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Of nature trusts the Mind that builds for aye"—WORDSWORTH

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CHILDREN AND THE CINEMA

TOWARDS the close of 1947 the Ministry of Education, the Home Office and the Scottish Office appointed a departmental committee under the chairmanship of Prof. K. C. Wheare to inquire into the effects of attendance at the cinema on children less than sixteen years of age. The report of its findings has now been published*. The Committee has not only interviewed witnesses, visited cinemas and studied memoranda from interested authorities, but has also carried out a number of supplementary investigations of its own. More particularly, in view of the widespread notion that the films are largely responsible for the increase in juvenile delinquency, it has addressed inquiries to chief constables, magistrates, psychologists at child-guidance clinics, and others, asking for opinions based on first-hand experience, and for specific instances (if any) supporting such views. In addition, it has conducted a small research on three hundred boys and girls in approved schools, and on members of children's clubs, in the hope of securing evidence from the children themselves. At the same time, and partly to assist the Committee's deliberations, the Social Survey of the Central Office of Information has undertaken three investigations along scientific lines, using appropriate sampling procedures, with the view of ascertaining the facts as regards the film-going habits of the general public and of the child population†.

The Committee finds no evidence for fastening on the cinema any primary share of responsibility for delinquency and crime. Save for exceptional cases, it believes the physical effects to be insignificant. The nervous effects it considers deplorable; and the general moral effects—the influence exercised on manners, moral values and standards of behaviour—to be subtle and far-reaching. It concludes that the cinema has "great power both for good and for evil".

As a result, the report recommends that "there should be clear and definite statutory provisions, requiring regulations to be made to prescribe minimum standards which must be observed to safeguard the welfare of children attending the cinema". It believes the existing method of classifying films to be unsatisfactory, and proposes an alternative procedure of its own. The task of classification should, it contends, be regarded as essentially different from that of censorship, and be carried out with the assistance of persons who are experts in child psychology. With this and other problems in mind, it is proposed that a central committee on children and the cinema should be set up forthwith by those government departments now concerned with cinema questions; the new body, it is stated, should include persons interested in child welfare, and particularly those who have made a scientific study of the psychology of children. Finally, the report strongly recommends that "scientific investigation should be undertaken as soon as possible into the effects of the cinema on children".

---

* Report of the Departmental Committee on Children and the Cinema. (London: H.M. Stationery Office, 1950.) 3s. net.

† Kathleen Box, "The Cinema and the Public" (1946); Joyce Ward, "Children out of School" (1948), and "Children and the Cinema" (1949), *The Social Survey*, N.S. Nos. 106, 110, 131 (1949).

An appendix is added to the report, setting forth a list of those problems which call most urgently for scientific study, and discussing the scientific procedures available for such researches. Among the problems enumerated, the report puts first and foremost those questions which it describes as largely physiological. What, for example, are the effects of the conditions of seating, temperature, ventilation, and the like, on the health and comfort of the children ? How far does attendance induce fatigue and eye-strain among children of different ages ? What part is played by differences between the brightness of the screen and that of the surrounding surfaces within the field of vision, and by the degree of illumination of the cinema as a whole ? What are the effects of the inevitable distortion in shape and apparent movement when the film is viewed from an oblique angle ? Although these problems are described in the report as essentially physiological, it ought perhaps to be borne in mind that advances in the study of visual perception have already shown that the psychological aspects of such problems are equally important, and that the views of physiologists and medical experts with no psychological training may therefore be gravely at fault. Secondly, the report enumerates a number of questions which it regards as more definitely psychological. These relate chiefly to the interpretation by the cinemagoer of what he sees upon the screen. At what age, for example, does the normal child begin to take in a story presented on the cinema screen, and when does he first acquire an interest in dialogue ? How far is he able to link together successive events and scenes in terms of cause and effect ? What features make some pictures seem more real than others to children of various ages ? One further topic mentioned in the body of the report might well be added to the list of researches set out in its appendix, namely, the possibility of teaching appreciation of films along the same lines as the appreciation of music, painting and industrial arts.

A third group of problems is described as social ; they relate chiefly to the cumulative effects of visits to the cinema on behaviour outside. Here the report considers the available evidence to be seriously defective. If such questions are to be made the subject of scientific research, then, it is rightly urged, special precautions and special technical devices must be employed. "Almost all the prevailing methods in this field," it is said, "rest upon assumptions which stand in need of further and more rigorous testing ; what is called the social survey can by itself rarely if ever reach a stage of settled conclusions able to satisfy exact scientific demands." The procedures commonly employed, we are told, "were invented for adult populations, and most of them in America" ; and the statistical procedures adopted for analysing the data thus obtained have "almost always been taken over without criticism from those that have proved successful in widely different fields".

Much of this criticism is no doubt fully justified, though it somewhat undermines the value of the evidence on which the Committee has based its own conclusions. It will, too, be generally agreed that a good deal of the earlier American publications dealing with such problems possess little scientific merit. In Great Britain, however, psychologists and educationists have been less inclined to trust exclusively to these more general procedures, and have always insisted that the statistical data obtained on an extensive scale by the cruder devices of the survey should be supplemented by intensive investigations of the case-study type. This has been especially so in the field to which the report has devoted closest attention, namely, that of juvenile delinquency. Here perhaps the Committee may have been a little handicapped by the fact that no leading educational psychologist, familiar with work already carried out, was included among its members.

Nevertheless, the Committee's final statement on the matter is undoubtedly sound. Although, we are told, further experimental studies of a laboratory type are urgently needed, "it cannot be too strongly emphasized that the world of films is a world of its own, whose problems cannot be studied in the laboratory alone". On the Continent, a systematic attempt has already been made to draw up, on an international basis, a list of the more important psychological and social problems raised by the rapid development of the cinema, and to suggest suitable techniques*. It is to be hoped, therefore, that the Committee's appeal for inquiries of a more rigorously scientific character will encourage teams of suitably trained investigators—physicists, physiologists, psychologists, educationists and sociologists—to cooperate in this important field of social research.

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* Cf. the recent report of *La Revue internationale de filmologie*, (V), 2, 1-20 (1949).

ANAXAGORAS : PHILOSOPHER AND ARTIST

The Philosophy of Anaxagoras

An Attempt at Reconstruction. By Felix M. Cleve. Pp. xxiv+167. (New York : King's Crown Press ; London : Oxford University Press, 1949.) 16*s.* net.

THE author of this book undertook, in a first "rudimentary attempt", to reconstruct as long ago as 1917 the philosophical system contained in the extant writings of Anaxagoras. Now we have the benefit of a further thirty years of study, and the scholarly treatise here before us is the result. Assuredly, the background cannot have been encouraging ; to more than one authority the task appeared meaningless. Moreover, early Greek thought is often regarded as merely fanciful. But we need not agree with these views ; they are not sacrosanct, and Dr. F. M. Cleve will have none of them. Even if he emerged from the fray as nothing more than an impenitent rebel, he would have earned our respect ; as it is, he returns bearing his sheaves with him—a not inconsiderable harvest.

Superficially, all this is somewhat peculiar. Below the surface, however, we may discern what has happened. The main purpose is to bring about a philosophical reconstruction rather than a philological one. In view of what remains of the master's writings, the latter enterprise could have had little chance of success; but so long as strict consistency obtains, the former is by no means hopeless. Yet the proposal to set out on the philosopher's way has brought into active commission more wet blankets than enough. In addition, it is very difficult to accept much of the Aristotelian comment and interpretation as trustworthy. Thus, at least one of the natural stepping-stones to a just assessment of the place in history of the wise man of Clazomenæ is decidedly slippery. Why exactly this should be so is not easy to see—the personal equation apparently was never without influence; and when the universal prestige of the Stagirite is added, the verdict is heavily weighted.

Anaxagoras has usually been understood to assume an infinite number of elements. In fact, he states as his opinion only that they are "numerous and diverse". Even so, this is a notable breakaway from the old Ionian tradition; yet the crux of the matter is the exact sense of the words, "seeds infinite in quantity". This phrase might refer to the number of the kinds of seeds, or to the number of the particles making up the various kinds. (How much clearer this idea might have become, had its originator lived to see the discovery of the algebra of classes, or the notion of a 'set'.) Nevertheless, for all his types of seeds, and how many there are, one thing is needful, namely, that not the slightest likeness must exist between them in any particular. This outlaws the atoms of Leucippus and Democritus—with their differences on geometry and velocity only—once and for all.

In the light of these tenets, the broad sweep of the Anaxagorean cosmogony begins to take shape, or rather, the associated world-making (κοσμοποιία). The first and second means are those of differentiation and rotation respectively, followed by both acting together. The third means involves dismemberment of the axis, and is by far the most obscure to modern minds. Dr. Cleve is at his best here, as he strives to disentangle it. Before we tackle this, however, it is well to recollect the unique position assigned to 'nous' (intellect or mind) in the present context. 'He' is not mixed with any element—he sits in sovereign-like detachment; he can do what he likes, because he knows exactly what he can do.

Thus, in starting with differentiation, 'nous' must upset the all-pervading balance or homogeneity of things, in order to produce the world's infinite variety as we know it. The process must begin at one point, or otherwise a species of statistical jumble would come about, inimical to world structure. In this is manifest a very primitive suggestion of entropy, as well as the implication that, had differentiation 'flared up' all over the place, nothing but a kind of gas kinetics would have arisen, with zero resultant.

So far, so good. The omniscient physicist–engineer–architect could not be satisfied with this order of Nature, however, for it offered by itself merely a stratified globe of increasing size. 'Nous' knew what to do next; he would introduce a 'going round about', with its 'quickness that produces force'. Rotation has arrived, and something uncommonly like angular-velocity. This is remarkable enough, but the motive is more intriguing still. It is unmistakably æsthetic. The master-builder's sense of fitness, appropriateness and function was outraged by the monotony of differentiation into strata; something altogether more lovely and satisfying was imperative. Hence, translation must be reinforced by rotation. The law of *prägnanz*, beloved of *gestalt*-psychologists these past few decades, to make the world safe for stationary states of minimal energy (including æsthetic), seems to have occurred to Anaxagoras almost overnight.

The moon caused him grave anxiety, especially in connexion with his plan for differentiation and rotation working together. Thales had established that moonlight was but reflected sunlight, but each heavenly body was, for Anaxagoras, a lump of glowing stone or μύδρος. It was hard to exempt the moon from this astrophysical generalization; yet it had to be done somehow, and its relative nearness to the earth, compared with the sun, did not help matters. So Anaxagoras retained the μύδρος character, but declared the lunar composition to be irregular, having hollows mixed with the cold. This incursion into metaphysics may offend us to-day: it was but a temporary expedient, honest and resolute. Many a natural philosopher has taken similar refuge in a storm.

With his theory of invisible celestial objects, the strong æsthetic sense in Anaxagoras bursts out anew. If symmetry demands entities invisible to us, it is legitimate to postulate their existence. There speaks the true artist.

But much of this, we gather, seemed trivial compared with the vast problem presented by day and night. So far, 'nous' had not provided for sunrise or sunset (or, for that matter, the corresponding effect for all the contents of the heavens). The identity of all the axes of rotation—accepted so far—must be abolished, the common axis dismembered. Without following the details of this severe operation, we can admire once again the intellectual fortitude of the master in facing the facts. This must, indeed, have occasioned a distressing "pain in the mind", particularly as all doctrines subversive of "authority" were dangerous to those who professed them.

Thus far, we have concentrated upon Anaxagoras the master-builder and natural philosopher. His distinguished place for all time must be mainly due to his efforts in those capacities. Yet, this amazing personality presents us with constructive comments in biology and psychology as well. An example is the remark, concerning the difference to be observed in relative intelligence between created things, that it is due to his having hands that man is the most intelligent animal. As Dr. Cleve points out, it is most odd that Aristotle of all people should have objected to this statement, even wishing in effect to reverse it.

These erudite pages end with a register of authorities. It is a formidable list; but the inclusion of a reference to Prof. K. O. Müller's interesting brief discussion of the Anaximander–Heraclitus–Anaxagoras 'triangle' ("Literature of Ancient Greece", 1; 1858) would have strengthened it still further.

Dr. Cleve has contributed something intrinsically more valuable and illuminating (in spite of one or two points upon which agreement is not assured) than anything that has appeared in recent years on the subject of Anaxagoras of Clazomenæ, with the sole exception perhaps of the late Prof. A. E. Taylor's "The Date of the Trial of Anaxagoras" (1917). In any event, what matters is to bring to light and examination every particle of knowledge which research can unravel concerning men of genius like this. As Prof. J. E. Littlewood once put it, "They are not clever schoolboys or scholarship candi but Fellows of another College".

F. I. G. R

AMID THE HIGH CAIRNGORMS

The Cairngorms on Foot and Ski

By V. A. Firsoff. Pp. 279+49 plates. (London: Robert Hale, Ltd., 1949.) 15*s.* net.

THE range of the Cairngorms is in the opinion of many people the finest mountain land in Britain. Mr. V. A. Firsoff in this book has written of his experiences of this hill range. He describes how he saw them first during the grim years of the Second World War, and since that day he has climbed and photographed them not only in summer, but also in winter when, like the Norwegian troops stationed in the district during the War, he has roamed their high plateaux on skis in all weathers, sometimes battling with blizzards so fierce that life itself seems precarious. The illustrations which he has taken with his camera show that he has an eye to a good picture; some of them are excellent. He writes clearly and graphically, and we follow him on his climbs from the Linn of Dee and from Achlean in Glen Feshie, from which hospitable house he first made the acquaintance of the Cairngorms in the war years.

Mr. Firsoff has a good deal to say about the ancient forests of Scots fir and their ruthless felling, not only during the War but also afterwards. I am glad that he directs attention to the danger that we may lose entirely these fine woods. This can be prevented, on the south slopes of the Cairngorms at all events, by fencing in areas against deer and allowing the seedlings to make a start. I have repeatedly urged this, yet nothing has been done; as it is, each seedling is eaten, and in Mar Forest there is not a single young tree to be seen. Mr. Firsoff writes of the recently formed National Park in Glen More, and the possibility of the whole range becoming a larger national park.

In his botanical chapter the author makes some surprising statements, as, for example, when (p. 46) he writes: "In Coire Beanaidh along the scarp of Sron na Lairig I came across carpets of purple saxifrage in livid bud, on the point of opening". I have known the Cairngorms for the best part of forty-five years but have yet to find, nor do I know any botanist who has found, this schist-loving saxifrage on the high tops or in the high corries of the Cairngorms, where the granite formation is distasteful to it. Nor (p. 48) have I found the blaeberry (*Vaccinium myrtillus*) abundant at the Wells of Dee where I have spent, at one time or another, a considerable number of days. The mossy cyphel has not been recorded from the Cairngorm area and not nearer than seventy miles from it. *Azalea procumbens* flowers earlier, and not later, than *Silene acaulis*, unless it has been kept back, as it sometimes is, by extensive snow fields remaining until late spring on its flowering slopes.

I am perplexed, too, by the author's Camberwell Beauty butterfly (p. 19), which he saw in winter in Glen Feshie. This butterfly is a rare vagrant and is seen mostly on the east coast. To have seen it in February in Glen Feshie surely merits more than a passing casual remark. There was never (p. 74) a colony of black-headed gulls on Loch nan Stuirteag.

On p. 88 he talks of seeing the Cuillin Hills of Skye from the Cairngorms, but he has confused them with the Sisters of Kintail. There is, it is true, a tradition in Rothiemurchus that the Cuillin are visible, but the shape of those distant pointed hills is not the shape of the Cuillin. I consulted the Ordnance Survey on this question, and they were good enough to interest themselves in the matter and informed me that, because of an intervening hill sixty miles distant, the Cuillin are invisible from the Cairngorms.

The book is excellently produced. In a second edition, which is sure to follow, the errors Uisga for Uisge (p. 14), statistickal for statistical on p. 36, and on p. 30 the English translation of Moine Bhealaidh will doubtless be rectified. SETON GORDON

IN PRAISE OF EPPING FOREST

London's Epping Forest

By James A. Brimble. Pp. 176. (London: Country Life, Ltd., 1950.) 30*s.* net.

WHEN you pick up this handsome book, you find yourself either immediately interested in Epping Forest ("It is little more than half an hour from Town. . . . And oh! so near to London!") or fascinated by the superb photographs.

Epping Forest is a comparatively large natural area stretching from the north-eastern edge of urban Greater London deep into the heart of rural, agricultural Essex. Part is actual forest; but other parts are suburban in character and there are some small areas of common, copse and verge. (Mr. Brimble deals only with a section of the forest.) It is a forest with a history, too. One needs only to mention such as the ancient British camps of Ambersbury Banks and Loughton, Waltham Abbey and Hainault to remind the reader that here was where much of Britain's history was enacted. Also as a forest, this area has for centuries played an important part. The Normans used the area for hunting. Deforestation occurred under the weak regimes of John and Edward I; but afforestation was the order of the day under nearly all the Henries. Then the area was the scene of many a royal hunt—the Norman kings, the Plantagenets, the Tudors and the Stuarts—reaching its peak with Henry VIII; but the hunts ceased after Charles II. The forestry programme of the area has suffered many vicissitudes, and even Parliament has not been guiltless of making easy money from the sale of timber that this area afforded; that is how the part known as Hainault Forest disappeared so recently as 1851. Finally in 1878, by an Act of Parliament, six thousand acres, now called Epping Forest, were placed under the administration of the Corporation of the City of London. Such is the position to-day.

We are told this, and much more besides, by the author, who then proceeds, in fifteen engaging chapters, to describe the Forest of to-day.

There is animal life, too. Domesticated cattle and horses from adjoining farms graze on the lawns (or Forest plains as they are called); the well-known deer number about two thousand. Some foxes are allowed, and almost invariably badgers eventually take over the formers' earths and enlarge them for themselves. Also, alas, the immigrant grey squirrel is now becoming a pest there.

The text abounds with descriptions which will appeal to all natural historians, for it is written by a man who has spent twenty-five years of his life on the edge of the Forest.

The most outstanding feature of the book, nevertheless, are the 115 photographs, all of which have been taken by the author. He is well known as a photographer of country-life, especially tree studies, and here he regales us with some of the best examples of his art. No lover of Nature, no amateur or professional photographer, could fail to be charmed by these studies of country-life taken in all moods and in every season, and through the medium of these photographs the book must appeal to many more than those who merely want to know about Epping Forest. Notwithstanding this, Londoners and others who contemplate visiting that area would do well to consult this book first.

Mr. Brimble (no relative of one of *Nature's* editors of the same name) is a book-seller, and the present volume is the fruit of his well-spent leisure. Both he and his publishers are to be congratulated on a well-written, superbly illustrated and handsomely produced book.

PRACTICAL PHYSICAL CHEMISTRY

Physico-Chemical Methods

By Prof. Joseph Reilly and Prof. William Norman Rae. Vol. 3 (Supplementary). Pp. ix+698. (London: Methuen and Co., Ltd., 1948.) 55*s.* net.

THIS book is a supplementary volume to the fourth revised edition of "Reilly and Rae" published in 1943. It contains much material that could not be accommodated in Vols. 1 and 2 and much additional information that has become available as a result of post-war advances in physical chemistry. It may truthfully be said there is no defined limit to physico-chemical methods. On one hand, much that the physicist has developed in other connexions is rapidly adapted and modified for purely chemical purposes; on the other hand, the application of physical chemistry to substances and reactions of biological interest has pushed forward to the extreme the developments of highly complex physical chemical methods. Due regard is paid in this volume to these important borderline activities in modern physical chemistry. From this it becomes evident that no pair of authors can possibly have even a nodding acquaintance with the limitless variety of topics that must find a place in a comprehensive reference book of this kind. A number of chapters are therefore written by other authors, who have a special knowledge of the subjects discussed.

The selection and balance of the topics is a most difficult one, and no two physical chemists would agree on this point. The book opens with a brief account of electron optics as a preliminary to a description of the electron microscope. Few physical chemists would now try to build such a highly specialized instrument; it is therefore a pertinent question as to whether valuable space in this book should properly be devoted to this subject. Similar remarks might be made of the chapter on the mass spectrograph, except that here an indication of its usefulness rather than its construction should now find a place in any physical text-book of an advanced character. The chapter on photo-physics—mainly on photocells—is extremely useful and could be expanded with advantage in a future edition, for chemists are not always aware of what can be done with these tools. The determination of atomic and molecular weights occupies a considerable portion, due emphasis being paid to micro methods for molecular weight determination. Osmotic pressure apparatus is adequately dealt with, and more information about modern instruments for measuring very small pressures would be welcome. The procedure, rather than the apparatus, for dealing with homogeneous reaction velocities is set out in detail so that effective use may be made of the more practical procedures described in other parts of the volumes. Chromatography properly gets its due quota of space, and the theory is properly considered so that the approach to it need not be purely empirical. The preparation of colloidal solutions perhaps occupies a rather large amount of space, since the quantitative significance of the subject is never particularly high. There are many more topics, but lack of space prevents their being mentioned.

The great value of a work of this kind is as a source book for guidance—it cannot be critical, for the subject is too vast. What it can and does do is to provide the reader with ideas, methods of approach and devices to help him in his particular problems in this field of chemistry. H. W. MELVILLE

GENERAL INTRODUCTION TO ADVANCED MAGNETISM

Magnetism

By Dr. David Shoenberg. (Sigma Introductions to Science, 12.) Pp. x+216+8 plates. (London: Sigma Books, Ltd., 1949.) 10*s.* 6*d.* net.

TO give a satisfying account of magnetism in some two hundred pages is a considerable undertaking; to accomplish this as excellently as he has done, Dr. Shoenberg must have given a great deal of thought to the impact of quantitative ideas and conventions on the general reader meeting them for the first time. In the early chapters, the single magnetic pole is soon discarded for the dipole, and the relation between magnetism, electricity and atomic structure is pursued via magnetic shells to electron orbits and the ultimate spin. None of the essential theory of elementary magnetism is omitted, but it appears in a guise less formidable and more convincing than usual.

The account of magnetic materials and ferromagnetics is valuable from two points of view: the domain-structure idea and some evidence for it are well explained; and there is also some quantitative discussion of such points as the importance of coercivity rather than merely remanence for a permanent-magnet steel, and what happens when a keeper is removed and replaced again. There are chapters on terrestrial magnetism, the use of magnetism as a tool in scientific work, and some everyday applications of it. These are not very detailed, but the book is professedly an introduction and lives up to this by giving a list of standard works in which the topics may be pursued further. The glossary-index combination is a useful idea. The diagrams are good, but the eight plates would have brightened the volume more if they had been spaced out instead of being centralized.

The author is lecturer in physics in the University of Cambridge and head of the Royal Society Mond Laboratory at Cambridge, having been there since 1932. As the publishers state, the book is of a more advanced character than most of the Sigma series and it should be useful to the serious student as as to the general reader, both of whom will app in its pages the authentic hand of the expe

G. R.

Umbundu Kinship and Character

Being a Description of the Social Structure and Individual Development of the Ovimbundu of Angola, with Observations concerning the Bearing on the Enterprise of Christian Missions of certain Phases of the Life and Culture Described. By Gladwyn Murray Childs. (Published for the International African Institute and the Witwatersrand University Press.) Pp. xviii+246+16 plates. (London, New York and Toronto: Oxford University Press, 1949.) 21*s*. net.

THIS is a useful study of the Mbundu, alias Ovimbundu, the largest and most vigorous tribal group in the Portuguese colony of Angola. The manuscript was completed ten years ago, and it is a pity that it could not have been published before, as it helps to fill a serious gap in our knowledge of this part of south-western Africa. It will be of considerable value not only to missionaries and those concerned with the government of this territory, but also to anthropologists, particularly those concerned with the study of social organisation and of social psychology.

The book contains three sections: the first dealing with the kinship structure and the bilateral aspects of Mbundu lineages; the second with the mental development and education of the individual in Mbundu society; and the third with Mbundu history. Those interested in the comparative study of southern Bantu peoples will find these studies extremely useful, but will probably share the reviewer's regret that the author has tried to compress into a book of 220-odd pages material that could well have gone into three volumes. As a result, certain sections of the book, particularly those dealing with kinship organisation, are obscure and lacking in explanatory details.

The editing is of the usual high standard set by publications of the International African Institute, although one wonders why the editor should want to increase publication costs by including plates of wounded bull elands, decapitated wart hogs and similar subjects having no relation to the text.

The Yeast Cell

Its Genetics and Cytology. By Carl C. Lindgren. Pp. xviii+358+7. (Saint Louis: Educational Publishers, Inc., 1949.) n.p.

THERE are many forms of life, once thought to be unusual, or even unique in their structure and functions, which have afterwards proved to be more orthodox than they were believed to be. So, in the case of yeasts, this book shows them to be conventional cells, possessing chromosomes, centrosomes and mitochondria, and behaving cytologically and genetically like any other cell. There are, indeed, aspects of the genetical behaviour of yeasts, especially the apparently irregular segregation of allelomorphs in certain cases, which may appear to support the heterodoxy which is sometimes claimed for them; but even in these cases, the author has abandoned the hypothesis of the maintenance, under the influence of a specific substrate, of a fermentative character for which no gene is present. He has also brought experimental evidence to reinforce the classical view of the importance of the chromosome, while revising and developing the concept of the physical nature of the gene.

The majority of the material is derived from the researches of the author and his associates, and the book is accordingly very profusely illustrated by plates, diagrams and tables. These suffer considerably from the off-set printing technique which, together with the unusual method of numbering the pages by chapters, gives the entire book an unfamiliar appearance. A more serious defect is the absence of an index, which is difficult to forgive in a work of this nature.

In view of the great and growing debt of enzyme chemistry and of genetics to the study of the yeast cell, the value of the book is unquestionable, and the field which it covers is wider than the subtitle suggests.

K. A. BISSET

The Living Soil

Evidence of the Importance to Human Health of Soil Vitality, with Special Reference to National Planning. By E. B. Balfour. Revised edition. Pp. 270+14 plates. (London: Faber and Faber, Ltd., 1949.) 15*s*. net.

THIS beautifully produced book diligently presents the faith of a sect which holds that 'vitality' of soil is important for human health. Incorruptibility can be approached through use of compost and organic manures on terms which the book sets out.

The exposition is sincere, but will have little interest to the man of science unless he be a sociologist. It would be a mistake to judge by orthodox scientific standards the tenets of this biologically based cult which freely uses the terminology of science but rejects its methodology, which confuses testimony with evidence and has a primitive approach to experimentation. The pseudo-scientific approach is exemplified by reliance on vitamin B as understood *c*. 1929. The book may be useful for its information about the Soil Association and the composition and aims of the Haughley Research Trust which was established to put compost-farming to the proof. It reveals a tangled, kindly web of thought, which deceives nobody except its spinners and voluntary adherents in search of comfort for their souls. Such people are more numerous than men of science; and it would be surprising if the book were not a success.

HUGH NICOL

Fish and Fish Inspection

By John D. Syme. Pp. viii+162. (London: H. K. Lewis and Co., Ltd., 1949.) 18*s*. net.

THIS book has been written primarily for the use of food inspectors and students preparing for the certificate of the Royal Sanitary Institute. It begins with brief descriptions of modern fishing-vessels and gear, and of the various fishing-grounds on which they work. Then follows an important chapter on how to identify the various species of fish commonly met with in British fish-markets and on fishmongers' slabs. The descriptions are expressed in plain language and each is accompanied by a black-and-white drawing of the species mentioned. The exclusion of all scientific terms from the descriptions is probably an advantage for non-specialists, but even they would certainly have benefited if at least the scientific names had been given in addition to the common names by which the different kinds are known to the trade.

Chapters on fish inspection, preparation and transport, and the various methods of fish processing appear to be adequate for the purpose. The book is well produced in an attractive format and should have a ready sale in trade circles.

G. A. STEVEN

FAMOUS EXPERIMENTAL APPARATUS IN THE CAVENDISH LABORATORY, CAMBRIDGE*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

HERE exists in the Cavendish Laboratory an extensive collection of apparatus used the great era of classical physics. The start modern physics is generally identified with J. J. Thomson's experiments on the electron in 1896, but revolution of equal importance was taking place in the times of Maxwell and Rayleigh, the first two holders of the Cavendish chair. Physics was becoming established as an experimental science with a field of its own apart from those hitherto embraced in natural philosophy and chemistry, and for the first time a home was being officially provided for it by the University, where students could do experiments and the staff could pursue research.

It is rather startling to realize at what a late date the idea of an experimental laboratory took shape. The earliest record of anything of the kind appears to be the laboratory in a wine-cellar in one of the professors' houses at Glasgow, which Kelvin fitted up in 1846. Clifton started a laboratory in a room at Oxford in 1868, and the Clarendon Laboratory was completed in 1872. Tradition has it, however, that this famous building was more used for demonstrations to students than experiments which they were allowed to perform themselves. Cambridge followed with the building of the Cavendish Laboratory, begun in 1871 and completed in 1874. Until that time the tradition throughout British universities had been that while the professor gave his lectures in natural philosophy in university lecture rooms, research was his private concern, to be carried out where he could. Just as Newton experimented in his rooms in Trinity Great Court, Cambridge, so Maxwell while at King's College, London, made some of his most famous experimental researches in a garret at 8 Palace Gardens, where he lived. When Maxwell was appointed to the chair at Cambridge in 1871, he planned a laboratory with rooms specially designed for experimental work of various kinds. Rayleigh, besides developing the practical classes, added a workshop to the laboratory, and started an apparatus fund. Under them the laboratory began to assume something like its modern form. Maxwell presented all his experimental apparatus to the Cavendish Laboratory, and much of the apparatus with which Rayleigh established the absolute values of the electrical units is also preserved there. It is of great interest to see how these men worked in the days when there were no instrument-makers and no skilled team of mechanics in a laboratory workshop.

Maxwell's earliest experiments were designed to test Young's theory of colour vision, that any colour could be matched by a suitable mixture of three primary colours. While still at Cambridge, before he was appointed to the chair at Marischal College, erdeen, in 1856, he made a top on which disks of ferent colours could be placed, so that when the top was spun these disks blended together. Three large slotted disks of the primary colours red, green and blue could be so adjusted that their areas had any desired ratio, and a smaller disk of the colour to be matched compounded with black or white was placed at the centre of the top. The original is in the Cavendish Laboratory museum, as is also his elaboration of the principle in his colour box. This has several very interesting features. If white light from a slit passes through a prism and forms a spectrum, by selecting certain portions of this spectrum and superimposing them on top of each other one can get a mixture of the three primary colours in any desired proportions. Maxwell very ingeniously reversed the apparatus. At the place where the spectrum is formed Maxwell placed three adjustable slits and illuminated them with white light. The eye replaces the source of light at the slit, and looking into the prism the three colours defined by the slits are seen superimposed to give a composite sensation. This is matched against a standard colour seen alongside it. The slits are connected by a black paper bellows ingeniously constructed so that it can be placed in any suitable position. It is very interesting to note that Maxwell used in his colour box the principle afterwards adopted in the Littrow mounting. The light passes through a train of two prisms, is reflected normally at a concave mirror and retraces its path. Another interesting device is that which Maxwell employed to measure the width of his slits. He had a thin tapered gauge which he rested on his finger and inserted into the slit, pushing it forward until it slid over his finger so that the same pressure was always exerted. The box in the Cavendish Laboratory contains most of the original optical parts; the prisms are badly corroded, but can be made to work by fastening thin plates to their surfaces with Canada balsam. Maxwell worked with this apparatus at 8 Palace Gardens while professor at King's College, London, and gave his first Royal Institution lecture in 1861 on the theory of the three primary sensations of colour.

While at Marischal College, Aberdeen, Maxwell worked on the theory of Saturn's rings. He proved that the rings could not be solid or liquid, but must consist of a number of discrete particles, and he constructed a small brass model to illustrate the perturbations of the satellites in the rings. This model is still in perfect working order. It has been suggested that Maxwell's work on the mutual influence of the components of the rings led him to speculate about the dynamical theory of gases.

Another treasured object in the collection is the apparatus with which Maxwell measured the viscosity of gases. It is recorded that, in order to measure the viscosity at different temperatures, his faithful wife stoked up the room to the requisite temperature by many fires and kettles of water, and that blocks of ice were brought in to cool it down when necessary.

Another very intriguing piece of apparatus is that for comparing the electrostatic and electromagnetic units. A comparison had been made by Weber and Kohlrausch in 1856, who by discharging a cond through a galvanometer were able to comp capacity in electrostatic and electromagne

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* From a Friday Evening Discourse at the Royal Institution on ay 12.

For his purpose Maxwell borrowed from Gassiot his "magnificent battery of 2,600 cells charged with corrosive sublimate". Maxwell balanced an electrostatic attraction of two parallel plates connected to the poles of this battery against the repulsion of two parallel coils in which a current from the battery passed in series with a large resistance of 1 million ohms. His result for the velocity of light was 288,000,000 metres per second.

Maxwell did little experimental work while professor at the Cavendish. What time he could spare from teaching and from the building and equipping of the new Laboratory, which was only completed in 1877, two years before his death, was mainly devoted to editing Cavendish's experiments on electricity and repeating the more important of them. One experiment carried out in the Cavendish Laboratory was the verification of Ohm's law. This was sponsored by a British Association committee, and the account of it appears in the British Association Report for 1876. It is rather striking to see how much scientific work was sponsored by committees in those days; some seventeen committee reports appear in the British Association journal for 1876, on such diverse subjects as the practicability of adopting a common measure of value in the assessment of taxation, the steering qualities of ships, and the suggestion of suitable research experiments to be carried out in chemical laboratories.

Maxwell's method for the verification of Ohm's law was to compare a long thick wire A with a short thin one B of similar resistance in a Wheatstone bridge, first obtaining a balance with a weak current and then testing whether the balance remained good for a strong one. The current density in the long thick wire was, of course, much less than in the short thin one, and any diversion from Ohm's law would be shown by the balance altering when the strength of the current was altered. The difficulty in the straightforward experiment was that the shorter wire heated with the current. It was necessary to alternate rapidly between strong and weak currents, so that the temperature of the wires should remain steady. A balance did not by itself prove the point, because there might on the average be a balance, although the resistance A was greater than B for a strong current and less than B for a weak one. If, however, the balance still held good when the weak current through B was passed in the reverse direction to the strong current through A, Ohm's law must be true. Maxwell proved that it was correct to one part in 10^{12}. This gave rise to his famous comment, "It is seldom, if ever, that so searching a test has been applied to a law which was originally established by experiment, and which must still be considered a purely empirical law, as it has not hitherto been deduced from the fundamental principles of dynamics. But the mode in which it has borne this test not only warrants our entire reliance on its accuracy within the limit of ordinary experimental work, but encourages us to believe that the simplicity of an empirical law may be an argument for its exactness, even when we are not able to show that the law is a consequence of elementary dynamical principles."

Maxwell also repeated Cavendish's famous experiments to prove the inverse square law. The apparatus consists of two concentric spheres, the inner of which can be connected to or insulated from the outer at will. The outer sphere is charged while connected to the inner, and the connexion is then broken. When the two halves of the outer sphere are removed, the inner sphere is found to be uncharge with his crude pithball electroscope, sl index of the distance was 2 to within way. Maxwell proved that it was correc in 20,000.

The apparatus with which Maxwell atte discover the mechanical angular momentu ated with magnetization of an iron core course, far too insensitive to detect this very effect, but it is very ingeniously constructed. core was set spinning and could be magnetiz demagnetized at will. A very slight movemen the axis of rotation could have been detected, none was observed.

When Maxwell was invited to go to Cambridg doubted his ability as an experimentalist and power to design a practical course for a class, and course, his fame rests on his very great contribu to theoretical physics. However, the appar shows that he was an able experimenter with a r gift for simple design.

Rayleigh succeeded Maxwell in 1879. His practi contributions to the Laboratory were the institut of an apparatus fund, the establishment of a wor shop with a mechanic, the reorganisation of t practical teaching under Glazebrook and Shaw demonstrators (whose book was the basis of practic teaching in so many university laboratories in t early days) and the gift of his Nobel Prize in 1 with which the Rayleigh Wing was built. While Cambridge he carried on the stupendous series original contributions for which he is so famou sixty in all were published during his Cambrid years, on subjects as diverse as the sensitive fla capillarity, colours of thin plates, resolving po acoustics and the balance. As experimental work, planned a series of investigations to which a te could devote its efforts and selected the establishm of the electrical standards in absolute meas Rayleigh's work on the British Association unit resistance, the specific resistance of mercury, E.M.F. of Clark cells, and the electro-chemical equivalent of silver was the basis of the internationall accepted units for the ohm, ampere and volt.

Brief reference may perhaps be made to one these determinations, because it had an interes sequel. With Schuster he repeated the determina of a resistance in absolute units which had carried out by a British Association committe appointed for that purpose, and corrected its resul which was very considerably in error. The metho consists in spinning a coil about a vertical axis wit a magnet suspended at its centre. The current induced in the coil by the earth's field cause th magnet to deviate from the north–south position Rayleigh drove the coil with a small water impuls engine fed from a tank in the roof of the Laboratory because he found this to give the most steady result The speed was measured by attaching a stroboscopi disk to the coil and looking at it through the slits o the prongs of a calibrated tuning fork. The coil wa driven by a string belt from the water turbine; an Rayleigh records that he tried various ways regulating the speed, but found it best in the en while watching the stroboscope to "allow the to run lightly through the fingers" and keep a on the stroboscopic disk in position by adjus their pressure. One can picture what a complica apparatus for control, probably involving valves, would be set up nowadays. He finally tr the errors of the British Association committe

the axial and transverse dimensions of
been transposed in a calculation of the
for its finite size; and in some mysterious
scovered, "after much vexation and delay",
self-induction, which also involved a cor-
had been measured on a scale ten times less
true value. A fascinating result of this
ent on resistance was that it led him to the
igh disk' as a method of measuring the strength
sound. In the first method to determine the
d of rotation, which Rayleigh afterwards im-
ved, a bell rang at the termination of a certain
nber of revolutions. Rayleigh noticed that the
net was displaced every time the bell rang and
ed this to the action of the sound of the bell on
mirror attached to the magnet. He set up an
aratus to investigate the effect, and this was the
in of the well-known 'Rayleigh disk', a standard
y of measuring the intensity of sound.

Finally, there is one other classic piece of apparatus
the Laboratory collection, which might be men-
oned because, although the experiment was done at
later date, it is in the classical tradition. This is
e magnetic detector which Rutherford brought
ith him from New Zealand, and with which he sent
ireless messages over a distance of about a mile. A
e bundle of steel wires is surrounded by a small
il; a current is passed through this to magnetize
e wires, and the coil is then attached to the antenna.
hen this picks up oscillations from a Hertzian
cillator, the alternating current in the solenoid
emagnetizes the steel wires, and this can be detected
a small magnetometer. Rutherford had high
es of his invention as a money-making proposition,
letter to his fiancée in 1896 shows. He hoped it
ght prove to be a means of signalling over ten
les or more to such places as lighthouses. The
ention was submitted to Kelvin, who was dis-
raging about it, and nothing further was done.
is was, of course, before the days of Marconi's
periments, and it is interesting to reflect what the
istory of wireless might have been had Rutherford
ot been diverted to other lines of research.

THE NEUROGENIC HEART AND ETHER ANÆSTHESIA

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IT has been shown[1] that the distinction between hearts which are inhibited by acetylcholine, in low concentration (10^{-8}), and those which are accelerated, usually by substantially higher concentrations (10^{-5}), corresponds essentially to the classical distinction between 'myogenic' and 'neurogenic' types[2]. These two contrasted types of heart also differ in ease of tetanization[3], simultaneity or sequence of the con-
traction throughout the intact heart[4,5]), etc. The
Ab action is also supported by an independent
diff oach, outlined below.

Neurogenic Type of Crustacean Heart

using ether (¼–½ saturated aqueous solution) as
anæsthetic for the isopod crustacean *Asellus*
ticus (neurogenic heart), striking differences have been observed between the sequence of events and those typical of ether anæsthesia in the mammals[6] (myogenic heart), which may well be correlated with their contrasted types of heart. In the mammals, ether anæsthesia affects first the highest centres of the brain, leading to loss of consciousness, on the afferent side, and to failure of spontaneous (that is, 'voluntary') movement on the motor side. Next, the centres of the brain stem—basal ganglia, cerebellum, etc.—are affected in order, from above downwards, and then the spinal centres, probably in the reverse order, from below upwards, leading to failure of spinal reflex activity, and to complete relaxation of the somatic musculature. Halted at this stage the anæsthesia leaves the vital cardio-vascular and respiratory mechanisms little affected, and the value of ether as an anæsthetic for the mammal is naturally dependent on the differential resistance of these mechanisms.

In *Asellus* the same general effects are evident, namely, the initial stimulation of activity, followed by a phase of general muscular spasticity, with ventriflexion of the body, which gives place to a second, feebler burst of activity—becoming local and unco-ordinated—and, finally, to complete relaxation. The essential difference from the sequence of events in a mammal is that the heart and respiratory organs (gills) are typically arrested as soon as, and often appreciably earlier than, somatic movements. There are individual variations in the precise time relations; but in no instance does the heart-beat outlast reflex somatic movements. In spite of the cardiac arrest, however, complete recovery from this stage is usual, and the anæsthetic has proved very satisfactory for this animal. Complete quiescence of the heart for periods up to one hour is not necessarily fatal. Chloroform acts in essentially the same way but is a less satisfactory anæsthetic because of its low volatility.

In recovery the sequence is reversed. The gut musculature is most resistant, and recovers first; next somatic movements recommence, and finally the heart and gills, again with some individual variation in the precise time relations. The recovery of the heart begins as a local twitching of the ostial valves, whence activity sweeps suddenly to the rest of the myocardium.

The demonstration that the heart of *Asellus* is neurogenic on Prosser's criterion has been confirmed on the isolated heart preparation, the effective concentration of acetylcholine for cardio-acceleration being essentially the same (10^{-5}) as for the intact animal[1].

Talorchestia is listed as a neurogenic type[1], and the response to ether of the heart of another amphipod crustacean, *Gammarus pulex*, has therefore been investigated. The response is essentially as in *Asellus*, with two minor differences: (*a*) the general sensitivity of the whole animal is greater, and (*b*) the relative sensitivity of the heart is greater. *Gammarus* therefore exemplifies the neurogenic type even more clearly than *Asellus*, on the present criterion.

If the anæsthetic be discontinued as soon as anæsthesia is complete, recovery in *Gammarus* is more rapid than in *Asellus*. Since the necessary time of exposure is shorter in *Gammarus*, it would seem that the anæsthetic produces other, invisible, effects the extent of which is simply proportional to time of exposure, irrespective of the degree of resistance of the neuromuscular systems (cf. *Diaptomus*, below).

The high resistance to anæsthesia of the vertebrate heart is conceivably a biological adaptation correlated with the absolute indispensability of an incessant circulation. Is an incessant circulation then not vital in animals with a neurogenic heart ? *Asellus* and *Gammarus* are possibly sufficiently small (say 10 × 3 × 1 mm.) for oxygen, adequate for the *quiescent* animal, to diffuse through the general body surface, and it would seem more critical to test larger Crustacea with a neurogenic heart. Available records[1,7] indicate that all decapod Crustacea are neurogenic, and the shore-crab, *Carcinus mœnas*, has therefore been used (after cutting a window in the carapace, within the heart-impression, and sealing with celloidin). As in *Asellus* and *Gammarus*, cardiac arrest is induced by ether (vapour, in air) at least as soon as somatic movements. Moreover, recovery is complete from the stage of complete quiescence of heart and limbs. The magnitude of the oxygen debt incurred during anæsthesia constitutes an interesting further problem. The rate of recovery in *Carcinus* is slow (1–2 hr. as contrasted with 2–5 min. for a lightly anæsthetized *Asellus* or *Gammarus*). Whatever the magnitude of the oxygen debt, it is normally not fatal, and the typical, apparently very unadaptive, response of the neurogenic heart to anæsthetics may be regarded as a physiological disability but not as an utter calamity.

The heart of *Carcinus* and of the other neurogenic crustacea does, in fact, show short periods of quiescence even in the normal animal. Vigorous somatic movements frequently induce temporary cardiac arrest, followed by rebound acceleration when the movement ceases. Heart and somatic activity are, indeed, closely linked, and bursts of activity in the limbs of the almost anæsthetized animal are frequently followed by a brief return of activity in the already quiescent heart. The extent of this extrinsic control of the heart may perhaps be regarded as an essential feature of the neurogenic heart. The isolated heart of *Asellus* (author, unpublished) freed of control from the c.n.s. shows, by contrast, a very regular rhythm, like that of a myogenic heart *in situ*.

Myogenic Crustacean Hearts

The cladoceran *Daphnia*, unlike other Crustacea, has a myogenic heart[8] on Prosser's criterion. Both *Daphnia* sp. and *Simocephalus* sp. have been tested by the ether method, and Baylor's conclusion[8] is confirmed. In both, cardiac activity outlasts all other movement except that of the gut. Rate and amplitude eventually fall, but the regular rhythm of the myogenic heart is well sustained.

The anostracan heart was found to be insensitive to acetylcholine and was believed to constitute a third type, completely devoid of innervation[1]. On the present criterion, however, the heart of *Artemia salina* is myogenic as in the Cladocera. The sensitivity of the whole animal is again high, as in the Cladocera examined. The heart of *Diatomus*, one of the few cardiac copepods[9], is neurogenic on the present criterion as on that of Prosser[1]. Data on the response to ether of cardiac forms in other groups of 'Entomostraca', particularly among the Conchostraca and Notostraca, would be valuable, since on present evidence the myogenic heart seems peculiar to Phyllopods among Crustacea.

Diaptomus is unusually resistant to anæsthesia—considerably more so even than the acardiac copepod *Cyclops*. Further, it shows no appreciable cardio-somatic interval in the progress of anæsthesia. That its heart is essentially neurogenic, however, is shown by its erratic action, correlated with limb movements, in the later stages of anæsthesia. Recovery from anæsthesia is slow and uncertain in proportion to its high initial resistance. Ether is contra-indicated as an anæsthetic here.

Hearts of Other Invertebrates

Preliminary experiments indicate that the hearts of nymphs of *Cloëon* sp. and of an agrionid dragonfly are myogenic, like the hearts of other larval insects, on other criteria[2,10]. The relative resistance of the heart is higher than in the Phyllopod Crustacea examined. The response to ether of the heart of adult insects, usually neurogenic[1,11], has not been tested. The hearts of Mollusca are myogenic[1,2], and that of *Planorbis* sp. is very resistant to ether-water, even when admitted via a local 'window' in the shell. It appears to be more resistant than the (unstriated) foot musculature. Information on the response to ether of the hearts of molluscs, annelids[12], tunicates (possibly neurogenic[13] and therefore exceptional among Chordates) and other groups, would be useful.

Conclusions

Ether acts essentially on nervous mechanisms[6], and the relative sensitivity of the neurogenic heart is probably an indication of the high degree of control of this type of heart by the nervous system. With the dorsal ganglion removed the heart of *Limulus*[4] becomes 'myogenic'[5], with sequential replacing simultaneous beat.

The main differences between the two types of heart may be summarized :

Neurogenic	Myogenic
1. Nerve ganglion running the length of the heart[2]	Localized ganglion tissue or ? absent
2. Simultaneous contraction[2,5]	Sequential contraction
3. High degree of control by c.n.s.	High degree of automaticity
4. Relatively insensitive to acetylcholine[1]	Relatively sensitive to acetylcholine
5. Accelerated by acetylcholine[1]	Depressed by acetylcholine
6. More sensitive to ether than somatic systems	Less sensitive to ether than somatic systems
7. Striated muscle[2]	Derived from smooth muscle
8. Tetanizable[2,3]	Non-tetanizable
9. Normally shows rest-pauses	Incessant beat, normally

More evidence on comparative histogenesis and on tetanizability is probably required.

Some indication of the nature of the relationship between ether and acetylcholine has been given[14]. It seems probable that ether antagonizes acetylcholine directly or indirectly, progressively reducing its effective concentration at vital sites in the neuromuscular systems. The concentration first falls below the high threshold necessary for stimulation of the neurogenic type, which is therefore progressively slowed. The myogenic type is at first unaffected, while at still lower effective concentrations the normal *inhibitory* effect of acetylcholine on this type is relieved.

It does not seem essential, in order to explain the contrasted effect of acetylcholine on the two types of heart, to conclude[15] that the myogenic type is devoid of nerve cell-bodies, the anatomical evidence for which is rather negative[1]. The mammalian heart shows a variable and even paradoxical response to acetylcholine under different conditions[16,17]; and the difference in response between myogenic and neurogenic hearts may therefore involve no fundamental anatomical difference.

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THE SCINTILLATION COUNTER

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WHEREAS the detection of alpha-particles in zinc sulphide screens by the visual observation of the individual scintillations which these particles produce dates back to the early spinthariscope of Rutherford and Crooks, the combined use of an appropriate scintillating phosphor and photomultiplier tube by Coltman and Marshall for alpha-particles[1], and by Broser and Kallmann for beta-particles and gamma-rays[2], heralded the new era of the scintillation counter. Since then, research workers in Great Britain, Canada and the United States have not been slow to appreciate the inherent possibilities of the new counting technique[3], and, as a result of the widespread enthusiasm which developed, there exists to-day in the hands of the nuclear physicist a new and extremely powerful instrument for the study of some of his many problems. That this is the case was very much in evidence at the scintillation counter conference held at Oak Ridge in June 1949. In particular, it has become possible to study the association in time of nuclear particles to within 10^{-8} sec.—and this is by no means the limit which can be attained—and to investigate the gamma-ray process with a detection efficiency many times that which is possible with the Geiger counter. Further, the operation of the device in a proportional sense permits entirely new investigations of the nuclear radiation from isotopes of extremely low specific activity. It is my main purpose here to review the important features of the method and then to indicate some of the more striking applications which have already been made.

The primary particle loses its energy in the phosphor by the excitation and ionization of molecules which may later be involved in the radiation of a fraction of this energy in the form of light. Thus with zinc sulphide – silver, for example, this fraction or 'physical' efficiency is approximately 27 per cent for alpha-particles, according to Kallmann[4]. The details of the exact mechanism and constitution of the phosphorescent centres in particular cases cannot be said to be clearly understood[5], and much work remains to be done to determine why the ratio of radiation capture centres for electrons freed from matrix ions to non-radiation capture centres is so large for certain phosphors only. More than this is required, however, for if the crystals should absorb strongly in the region of the spectral distribution of the radiated photons, then the 'technical' efficiency will be low and it will be possible to work only with thin layers of the material. Thus zinc sulphide is relatively opaque in layers greater than 80 mgm./cm.^{2}, and yet anthracene and sodium iodide – thallium appear to be almost completely transparent even in thicknesses of several centimetres. There also exists obviously the necessity for matching the sensitivity curve of the photomultiplier cathode with the distribution of the spectral emission of the phosphor.

We anticipate that the system will behave as a proportional counter if the technical efficiency is independent of the energy of the primary particle, and the crystal dimensions are large compared with the particle-range. Evidence has accumulated to show that this is certainly the case with sodium iodide – thallium[6] and anthracene[7], for beta-particles of 100 keV. to several million electron volts, but that heavy particles of similar energy will give smaller pulses in most cases. This difference in behaviour may be due to surface effects at the crystal, saturation or quenching effects due to high ionization density, or differences in the emission spectrum of the phosphor for particles of widely different masses. Kallmann has reported[4] that, for alpha-particles and a zinc sulphide screen, the pulse heights are proportional to energy down to 100 keV.

Other properties of the phosphor may be involved. The formation of metastable states in which the quanta are emitted over a fairly long period (greater than 100 microseconds for potassium iodide – thallium, for example, due to the nature of the trapping centres formed by the thallium) will mean that good resolution in coincidence experiments will not be attainable. The organic phosphors are supreme with respect to the rapidity of the light-emission process, and in particular anthracene (2×10^{-8} sec.), stilbene (8×10^{-9} sec.) and pyrene (less than 5×10^{-9} sec.) are among the fastest known phosphors[8]. These times represent the effective decay times of the pulse, the times for the rise being too short to measure with the equipment which was used. In order to obtain the greatest efficiency for the detection of gamma-radiation, the density of the crystal should be high and it should contain atoms of high atomic number; but whereas in this respect the inorganic phosphors such as cadmium tungstate (density 8, critical angle 28°) are desirable (Linde Air Products), the high refractive indices of some of these involve special problems in getting the light out of the crystal. Grinding the surfaces to help diffuse the light, or blooming, may help considerably in this respect. At the time of writing, it would probably be fair to say that the best phosphors available are thin layers of activated zinc sulphide or cadmium sulphide for alpha-particle detection; anthracene, stilbene, diphenylacetylene and pyrene for high-speed counting and coincidence counting; and sodium iodide – thallium and the tungstates for high gamma-ray efficiency where short resolving-times are not required. Tables of the properties of some of these materials were published recently[7]. One must, of course, always consider the ease with which a particular phosphor can be prepared, especially if a large single crystal is required.

The recent development in Britain of the *E.M.I.* 5311 photomultipliers and in the United States of the *R.C.A.* 5819 tube has rendered much easier the whole problem of collecting light from the crystal on to the sensitive surface of the multiplier. These tubes have large semi-transparent cathodes which are mounted directly at one end of the inner surface of the glass envelope. The *R.C.A.* 931*A*, 1*P*21 and 1*P*28 tubes formerly made this problem a very difficult one, particularly for large crystals, because of the disposition and small size of the sensitive cathode surface. We have used the 5819 tubes in this way with crystals of several cubic inches in volume, without the need for resorting to the use of conical 'light pipes'. One feature of the 5819 operation which should be noted is its susceptibility to magnetic fields, which implies that a mu-metal screen should be used to avoid the effects of even the earth's field. In the region of a strong magnetic field, it may, however, be necessary to separate the multiplier and crystal, using a light pipe of lucite or quartz. In conjunction with a semicircular beta-ray spectrometer we have used lucite rods 1½ in. in diameter and 2 ft. long, and at Berkeley the use of light pipes 12 ft. long has been reported by Wouters in the detection of very high energy electrons[6]. Collins has found quartz to be twice as good as lucite[8].

The *R.C.A.* 5819 tube may have a useful gain of the order of a few hundred thousand when used at 100 volts per operating stage. The multiplication process is liable to statistical fluctuations, however, and this matter must be given careful consideration when we come to deal with the use of the system as a proportional counter. Let us consider what might be a typical situation. A 500-keV. electron in a certain crystal phosphor produces, say, 10,000 photons, and one half of these are collected by the photocathode. Some small fluctuation in this number must be expected in view of the nature of the processes taking place in the crystal. If the photo-electron conversion efficiency of the cathode be 5 per cent, the number of photo-electrons will be 250, and will be liable to a deviation of approximately $\sqrt{250}$, or 6½ per cent. Thus the deviation in the multiplier output voltage might be of the order of $6\frac{1}{2}\sqrt{\frac{4}{3}} = 7\frac{1}{2}$ per cent, giving a width to the distribution of pulse-height of 15 per cent, if we assume that the spread produced by the multiplication process itself introduces a factor $s/(s-1)$, where s is the secondary multiplication ratio of each dynode[8]. In any event, the effect has been shown to be relatively small when the number of photo-electrons from the cathode is large, as in this case[9]. It should be noted that it is essential to stabilize carefully the voltage supply to the multiplier, as the gain varies approximately as the seventh power of the voltage.

We have devoted some attention to the development of the scintillation counter as a gamma-ray spectrometer of low resolution[6], utilizing the nature of the relationship between secondary beta-particle energy and photomultiplier pulse-height output. Crystals of sodium iodide – thallium and 5819 photomultipliers have been used in this work, and the analysis of the pulses after suitable amplification has been achieved by means of a single-stage differential pulse-height selector, which counts only those pulses the amplitudes of which lie in a given range of pulse-heights. This circuit has a great advantage over the integral type of discriminator but will be replaced shortly by a five-channel differential instrument. If a gamma-ray of energy W_γ passes through a crystal, then Compton recoil electrons may be produced with all energies up to a maximum given by

$$W_c = W_\gamma\left(\frac{1}{1-0\cdot511/2W_\gamma}\right),$$

in addition to photo-electrons due to external conversion effects particularly in the iodine atoms in the lattice for gamma-rays of a few hundred thousand electron volts, and positive and negative electron-pairs for gamma-rays of high energy. The identification of this maximum energy W_c, due attention being given to the finite resolution of the equipment, will allow a measure of W_γ, as will the energy of the appropriate photo-electron peak (of energy $W_\gamma - W_K$) or pair-production peak (of energy $W_\gamma - 1\cdot02$ MeV.). In the region of energies up to 1 MeV. we have found it possible to resolve prominent photo-electron lines in the distribution curves (resolution 18 per cent at 400 keV.). From 1 MeV. to 2 MeV. the shape of the Compton distribution must, in general, be used to identify energies; but above 2 MeV. it is possible to resolve sharp peaks due to pair-production processes (resolution 8 per cent at 4·4 MeV.). (Some results by Johansson[10] have just come to our attention. These appear to give photo-electron peaks at an energy as high as 2·8 MeV. It is difficult to see how this can be so, in view of the very small yield of photo-electrons for $Z = 53$ at this energy.)

We have recently used the scintillation spectrometer[11] to measure the energy of the gamma-ray from potassium-40, and a value of 1·47 ± 0·03 MeV. has been obtained by comparison with the end-point of the distribution, substantially due to the Compton effect, for the 1·33 MeV. gamma-ray of cobalt-60 (Fig. 1). This result, taken in conjunction with certain theoretical conclusions, suggests that the energy of the *K*-capture process to the excited state of argon-40 is less than 0·13 ± 0·03 MeV. The background curve refers to the spectrometer when enclosed in a 3-in. lead castle. In our experiments, 90 gm. potassium chloride was used, a much smaller quantity than was required formerly in absorption measurements which gave a value of 1·55 ± 0·05 MeV. for the gamma-ray energy[12]. The photomultiplier noise-level becomes apparent at pulse-heights corresponding to approximately 20 keV., thus indicating a lower limit to the energies which can be studied without refrigeration[13].

Further interesting experiments have been conducted with the much-studied gold-198 isotope, and the existence of a rare (less than 1 per cent) high-energy gamma-ray of approximately 1·10 MeV. has been verified by a detailed comparison with the cobalt-60 end-point, as above[14]. A very prominent peak is due to the photo-electric conversion of the

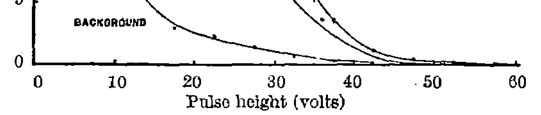

Fig. 1. Differential pulse-height distributions obtained with scintillation spectrometer. The curves for potassium-40 and cobalt-60 have been corrected for background

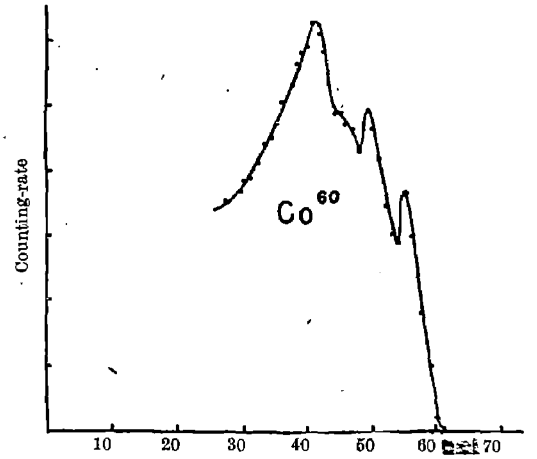

Fig. 2. Differential pulse-height distribution curve for highly collimated cobalt-60 gamma-rays, and a small sodium iodide crystal. The 1·17-MeV. Compton edge is well resolved, and also peaks due to combined Compton and photo-electric effects, for both the 1·17-MeV. and 1·33-MeV. gamma-rays

411-keV. gamma-ray in the crystal, as at this energy the photo-electron and Compton cross-section for iodine are comparable. Similar effects can be resolved above 1 MeV. if collimated rays and small crystals are used, as shown in Fig. 2, but for many investigations involving low-level gamma-ray intensities or coincidence work, such an arrangement is not desirable. In similar work, R. Hofstadter has obtained somewhat better resolution with an *E.M.I.* photocell (private communication). Experiments reported by us earlier[6], using large crystals, do not show the structure of Fig. 2. Some information has been obtained of the excited levels of carbon-12, produced in the Po α–Be reaction, by a study of the distributions due to the weak gamma-rays the energies of which we have measured as approximately 4·40 MeV. and 7·2 MeV. (see Fig. 3). Calibration of the energy-scale is made on the basis of the 2·62-MeV. gamma-ray of thorium C″. The source used for this calibration was 10 gm. of thorium nitrate, thus indicating the extreme sensitivity of the equipment. No substantial evidence is obtained here for gamma-rays from carbon-12 of energies in the range 2–4 MeV.

Work with the gamma-ray scintillation spectrometer is being pursued vigorously, and the co-operation of the Chemical Division of the National Research Council of Canada has been sought to obtain the purest materials for the study of possible gamma activities in members of the isobaric pairs of nuclei of neighbouring atomic number which occur in Nature. Work with less pure materials has shown up activities due principally to trace quantities of thorium. However, some particularly interesting results have been obtained with lanthanum-138, which exhibits a double anomaly and is one of the rare odd-odd type nuclei, and it is thought possible that this decays by K-capture to barium-138 with the emission of a gamma-ray of approximately 1·05 MeV.[15]. On this basis the half-life has been estimated as $\leqslant 1\cdot2 \times 10^{11}$ yr. In some of this work we have attempted to use cadmium tungstate as the scintillating crystal to obtain a more prominent photo-electric effect, but without much success.

Some interesting work has been done by Jordan and Bell at Oak Ridge, and a recent report[7] shows that some parallel developments are in progress there, particularly with regard to the use of a low-resolution beta-ray scintillation spectrometer in which anthracene has been employed. Sources a thousand times less active than those required by conventional spectrometers can be used.

To enter the millimicrosecond region of nuclear particle time-correlation studies will mean the discovery of many new facts about metastable states and will make possible accurate coincidence experiments for the elucidation of nuclear-level schemes, which could not be undertaken with Geiger counters. Some progress has been made[16] and various projects are under way in certain universities and research establishments. The 5819 photomultiplier gives a pulse output the width of which, due to transit time variations, is 5×10^{-9} sec.; but in Britain some success has been achieved by R. Kompfner of Oxford[4] in attempts to develop multipliers in which this variation is less by a factor of approximately 100. Wide-band distributed amplifiers are now available with a rise time of only 0·003 microsec. (Spencer Kennedy Laboratories, Cambridge, Mass.), but these may not be necessary if the fourteen-stage multipliers reported by Morton[8] eventually become available. These have a gain of 10^{11} and can produce pulses of some fifty volts for single electrons. A similar performance can be attained if experiments with pulsed multipliers are successful. Fast pre-scaling units with an input resolving time of 0·25 μsec. can now be obtained (Atomic Instruments Co., Boston) and are necessary for this work. Extremely fast coincidence circuits with a resolving time of 10^{-9}–10^{-10} sec. have been developed[17], but a simple and efficient system is to 'gate' the last stage of one multiplier by the output of the other. The resolving time of 5×10^{-9} sec. has been obtained by this procedure (Wouters[9]).

The crystals for use in this short time-interval region have already been indicated. We have attempted to combine some of these features with the proportional properties of the scintillation counter in the development of a coincidence scintillation spectrometer in which some of the difficulties of working discriminator units at extremely short resolving times are avoided. This unit can be used for beta-gamma or gamma-gamma coincidence studies with low resolution of energies, but a similar system in which the beta-energies are resolved in a semi-circular focusing spectrometer is also being used. A

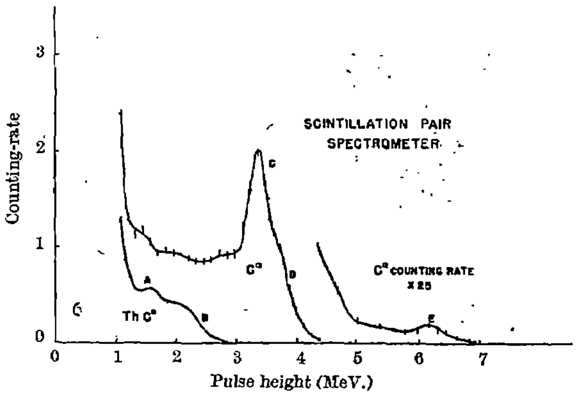

Fig. 3. Differential pulse-height distributions, showing the pair-production peaks obtained with high-energy gamma-rays. The thorium C″ 2·62-MeV. gamma-ray has been used to calibrate the pulse-height scale
(*A*) Pair production due to thorium C″ 2·62-MeV. gamma-ray.
(*B*) Compton edge due to thorium C″ 2·62-MeV. gamma-ray.
(*C*) Pair production due to carbon-12 gamma-ray (4·40 MeV.).
(*D*) Compton edge due to carbon-12 gamma-ray (4·40 MeV.).
(*E*) Pair production due to weak carbon-12 gamma-ray (7·2 MeV.).

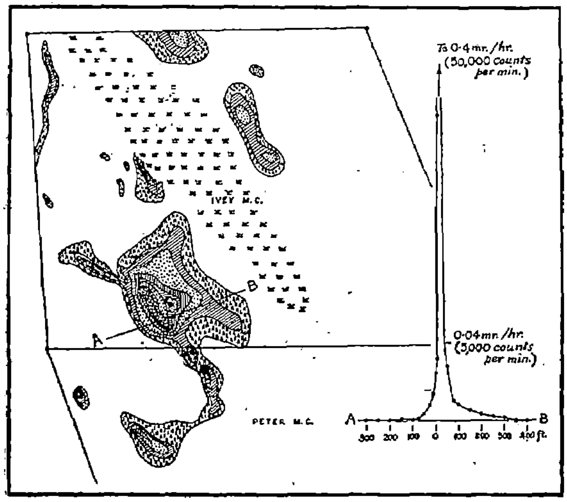
To 0·4 mr./hr. (50,000 counts per min.)
0·04 mr./hr. (5,000 counts per min.)
IVEY M.C.
PETER M.C.
A
B
A
B
300 200 100 0 100 200 300 400 ft.

Fig. 4. Scintillation counter radiation survey at Goldfields, Saskatchewan. (Intensity zones indicated by varying pattern of shading)

large semi-permanent magnet is being employed for this work.

Many other interesting developments are taking place. At Berkeley some work has been accomplished in the detection of high-energy electrons by the use of anthracene probe counters in the 300-MeV. synchrotron for the location of the electron beam. Fast protons have been investigated in an absorption coincidence device which has also been used to measure the cross-sections of various elements for fast neutrons. Anthracene crystals have been used for the detection of fast neutrons by exposing the crystals to the neutron beam for a known time interval and then measuring the induced carbon-14 beta activity. A similar method has been investigated by us in which a sodium iodide – thallium crystal is exposed to slow neutrons and the induced beta-activity due to iodine-128 (25 min.) is observed. Anthracene can be used directly, however, for the study of fast neutrons, the scintillations being caused by the recoil protons produced in the crystal; this might lead to a method for the measurement of neutron energies, except that the high sensitivity to gamma-rays is a grave disadvantage. Some successful methods have been developed for the detection of slow neutrons either by the use of lithium fluoride or lithium iodide crystals[18,19]. It is interesting to note that Wouters has found that the photomultiplier tubes can be used by themselves to count neutrons with an efficiency of 0·01 per cent for 300-MeV. neutrons. He attributes the process to the local heating of the surface caused by recoil nuclei, and has observed similar pulses for neutrons from a radium–beryllium source of height smaller by a factor of twenty.

Applications of the technique to cosmic ray research have been made[20], but it is anticipated that much more will be heard of this aspect when very large transparent crystals are utilized. Some further results are worth noting. Hofstadter, using stilbene crystals, has verified the simultaneity of the recoil electron and scattered quantum in the Compton process to within 10^{-8} sec., and has verified the angular distribution of the scattered quanta as given by the Klein–Nishina formula[8,21]. Deutsch has devised a coincidence system to measure the half-life of the positron[8,22] and obtained a value of $1\cdot05 \pm 0\cdot1 \times 10^{-7}$ sec. at 1 atmosphere pressure with nitrogen, as a result of a study of delayed coincidences between nuclear gamma-rays from a positron-active sodium-22 source and the annihilation radiation produced on the disappearance of the positrons.

The advantages of the scintillation counter are not limited to their application to academic physics. The use of high-sensitivity gamma-detectors for radioactive tracer technology is one obvious development which will mean the use of much smaller doses than are used at present. Work in this direction is proceeding in the Medical Department of the University of Manitoba. Portable scintillation counters for geological field-work were developed for the first time in 1949 in Canada[23]. It was found possible to devise a portable instrument weighing no more than 10 lb. which has a detection sensitivity for radium gamma-rays of 5×10^{-11} r./sec. with a response time of 16 sec. One reason for this great increase over the sensitivity in detection of the Geiger counter is the relatively small part of the normal background (a few per cent) which is due to cosmic rays. Tests in the Lake Athabaska area of northern Saskatchewan during the summer of 1949 gave excellent results, and indicated unknown uranium deposits in areas previously closely surveyed by Geiger counters. Isorads, or lines of equal radiation intensity, can be plotted to delineate areas of geological interest (Fig. 4). Further, it is possible in the field to distinguish roughly between the effects due to thorium and uranium ores, because of the different gamma-ray spectra involved. A commercially developed model of this instrument has been produced by Halross Instruments, Ltd., Winnipeg.

Enough has been said to suggest that although a certain amount has been accomplished, further intensive research and study in this new field will continue to yield results of considerable interest and importance.

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NEWS and VIEWS

Mathematics at Nottingham :

Prof. H. T. H. Piaggio

After forty-two years of service to the University College and, afterwards, the University of Nottingham, Prof. H. T. H. Piaggio is about to relinquish the chair of mathematics which he has held with such great distinction. Born in June 1884, he was educated at Lyulph Stanley School and the City of London School, and received his main mathematical training at St. John's College, Cambridge, during 1903–08. He was a Wrangler in 1906, and gained an honourable mention for the Smith's Prize in 1908. He took the London (external) B.Sc. degree with first-class honours in 1905, and this paved the way for the award of the London D.Sc. in 1914. After short periods of service at Battersea Polytechnic and with the Secondary School of Woolwich Polytechnic, he went to Nottingham as a junior lecturer and was eventually promoted professor in 1919.

In Nottingham Prof. Piaggio has built up a great reputation as a first-rate teacher of mathematics; he has probably had a smaller percentage of unsuccessful degree candidates than any other university teacher of mathematics. His book on differential equations is a model of its kind, which has run into twenty editions and has been translated into several languages. He is well known for his researches on the algebra of invariants and, of course, on differential equations, and many readers of *Nature* must have enjoyed his clear expositions of relativity matters and his pithy reviews of mathematical works. Prof. Piaggio will be much missed by his colleagues, who have found in him a wise counsellor, and a loyal and cheerful colleague who has been known to do many a kind act by stealth. He will take with him wholehearted good wishes for a happy and active retirement in which he may still enjoy many a good game of chess.

Prof. H. R. Pitt

Prof. H. R. Pitt, who will succeed Prof. Piaggio in January 1951, went to Cambridge, where he took his B.A. degree with distinction in 1935. He then began research under the late Prof. G. H. Hardy, and in 1936 was elected a bye-fellow at Peterhouse. In 1937 he gained a Smith's Prize and then spent a year at the Massachusetts Institute of Technology under Prof. Norbert Wiener. After taking a Ph.D. at Cambridge, Prof. Pitt spent two years as assistant lecturer at Aberdeen, and then three years in operational research at the Ministry of Aircraft Production and the Air Ministry; he reached the grade of senior scientific officer before his retirement in 1945. Since then he has been professor of mathematics in Queen's University, Belfast, where he has earned a high reputation both for teaching and the direction of research. Prof. Pitt has published a large number of papers on mathematical analysis, which have appeared in the *Journal for Mathematics and Physics*, *American Journal of Mathematics*, *Duke Journal*, *Journal and Proceedings of the London Mathematical Society* and the *Proceedings of the Cambridge Philosophical Society*. These deal with Fourier series, Tauberian theorems, Mercerian theorems, integro-differential equations, and similar topics. Although Prof. Pitt's chair is that of pure mathematics, and his published work is primarily in that field, much of it has applications to physics and statistics, of which he has a keen appreciation, believing that pure and applied mathematics are best treated in a unified way as two aspects of the same discipline.

Chemistry at the University College of North Staffordshire : Prof. H. D. Springall

Dr. H. D. Springall, who has been appointed to the chair of chemistry in the University College of North Staffordshire, has a wide chemical interest and experience, and possesses the rare distinction of an equal facility in both the organic and physical aspects of chemistry. He gained an open scholarship at Lincoln College, Oxford, in 1930, and graduated with first-class honours in 1934. Appointed to a senior demyship at Magdalen College at this time, he carried out researches on the molecular structures of organic compounds under Prof. N. V. Sidgwick, and on the steroid hormones under Sir Robert Robinson, and was awarded the D.Phil. degree in 1936. His early interest in structural chemistry was rewarded by his appointment to a Commonwealth Fund fellowship, during the tenure of which he worked with Prof. Linus Pauling at Pasadena. He returned to Oxford in 1938 to continue his association with Sir Robert Robinson in studies on the chemistry of proteins. On the outbreak of the Second World War, Dr. Springall became a scientific officer to the Ministry of Supply (Armament Research Department) and moved to the University of Bristol to work under Prof. E. L. Hirst. He was appointed a senior scientific officer in 1944 and was transferred from Bristol to Manchester in 1945.

After the War, Dr. Springall returned to academic work as lecturer in chemistry at the University of Manchester, where later (1948) he was appointed senior lecturer. His researches in recent years have been concerned mainly with the physical aspects (dipole moments, molecular structure and heats of combustion) of organic molecules; but his interest in the chemistry of proteins has remained, and his book on this subject is in course of publication. Dr. Springall's abilities as a lecturer, both to students and in his extra-mural courses, and his work as tutor at Dalton Hall have been widely appreciated at Manchester. A man of wide cultural background (who includes mountaineering among his various hobbies), he combines a varied experience with a great personal charm that has gained him many friends, and which should guarantee the successful growth of a new school of chemistry at the new University College.

The Premio Europeo Cortina Prize : Prof. John Read, F.R.S.

Prof. John Read, in acknowledgment of the award to him of the Premio Europeo Cortina Prize, visited Italy in May, under the auspices of the British Council, and delivered lectures in Turin, Milan, Pavia, Padua, Verona, Trento, Parma, Ferrara, Bologna, Florence, Rome and Naples. The lecture most in demand dealt with "La Storia della Scienza come Strumento di Cultura" (Historical Science as an Instrument of Culture"), and he spoke also on some modern researches in terpene chemistry and stereochemistry. Italian men of science, both academic and industrial, expressed great appreciation of the visit, and showed a common eagerness for a closer cultural association between Italy and Great Britain. In Rome, Prof. Read was invited to lecture not only in the University but also in the celebrated Palazzo Venezia. In several centres he established cordial contact with the Italian Chemical Society, which sponsored some of the meetings.

New Unstable Cosmic Ray Particles

In an important paper (*Phys. Rev.*, 78, 290; 1950), Prof. Carl Anderson, of the California Institute of Technology, together with four colleagues, A. J. Seriff, R. B. Leighton, C. Hsiao and E. W. Cowan, presents conclusive evidence for the existence of two new unstable cosmic ray particles. Using a counter-controlled cloud chamber in a magnetic field of 6,500 gauss, 3,000 photographs of penetrating events were made near sea-level and 8,000 at an altitude of 3,700 m. In all, 34 'forked tracks' were found, similar to the two photographed in Manchester by Rochester and Butler (*Nature*, 160, 855; 1947), and interpreted by them as representing the decay of neutral and charged unstable particles of a new type and of mass around 900 electron masses. Of Anderson's 34 forked tracks, 28 were due to the decay of neutral particles and 6 to the decay of charged particles. The mass of the unstable particles was estimated as probably between 250 and 400 electron masses greater than the sum of the masses of the decay products. It was further suggested that perhaps all the particles may not have the same mass. Evidence is provided that at least some of the decay products are nuclear interactive and are thus most probably π-mesons, or conceivably protons.

From the distribution of decay processes across the chamber, the life-time of the neutral particle was determined as $(3 \pm 2) \times 10^{-10}$ sec., and some evidence was obtained which indicated a considerably shorter life for the charged particles. These figures show that Rochester's and Butler's crude estimate of life-time, based on only two examples, was too high by a factor of over a hundred. These new particles are certainly so massive as to put their artificial production in the laboratory at least a few years in the future. Thus the accurate determination of the masses and life-times of the particles, and of their possible relation with other reported examples of very heavy mesons decaying in a different manner or not decaying at all (Brown, *et al.*, *Nature*, 163, 87; 1949. Harding, *Phil. Mag.*, 41, 405. Leprince-Ringuet, *Rev. Mod. Phys.*, 21, 42; 1949. Butler, Barker and Rosser, *Phys. Soc.*, 63, 145; 1950), will remain a major task of cosmic ray research in the next few years.

National Collection of Industrial Bacteria

A national collection of industrial bacteria was begun at the Chemical Research Laboratory (Department of Scientific and Industrial Research) early this year. It took over the non-pathogenic cultures held by the National Collection of Type Cultures at Colindale, and now houses some three hundred and fifty types. This number is expected to increase considerably as the Collection becomes more representative of the needs of industry. The Laboratory will maintain any organism which has ceased to be of interest but which may be wanted later. It frequently happens that a particular organism is destroyed when it has fulfilled its temporary purpose and yet may be required in the future at short notice. The Laboratory will also maintain any organism which for one reason or another should be duplicated. Most of the non-pathogenic bacteria supplied up to now by Colindale can be obtained from the Chemical Research Laboratory, and the Laboratory will try to procure any type of non-pathogenic culture which it does not hold itself. In time, it is hoped that the collection will become comprehensive, and gaps are being filled by obtaining cultures from other laboratories in Great Britain and abroad. Particular emphasis will be given to assay organisms. Cultures held by the Collection will be included in the United Kingdom List of Species to be published in 1951. Inquiries should be addressed to the Director, Chemical Research Laboratory, Teddington, Middlesex.

The Brotherton Collection, University of Leeds

The fourteenth annual report of the Committee for the Brotherton Collection of the University of Leeds, covering the session 1948–49 (pp. 9; Leeds: the University, 1950), records the contents of the Collection on June 30, 1949, as 22,887 books, 15,642 pamphlets, 477 manuscripts, 4,105 deeds, 31,251 letters and 25 maps. The first public exhibition of the session was arranged in connexion with a visit of delegates to the International Geological Congress held in London, while another exhibition, on the history of printing, illustrated lectures at the Leeds College of Art and the Department of Printing of the Leeds College of Technology. Visitors during the session numbered 850, including twenty-eight organised parties. A list of acquisitions is given in the report.

Newfoundland Biological Station for Fishery Research

Fisheries research in Newfoundland, which was formerly the responsibility of the Newfoundland Government Laboratory, is now being carried on under the Fisheries Research Board of Canada. The name of the Laboratory has been changed to that of the Newfoundland Biological Station. This Station will in future carry on work in marine biology and hydrography only. With Bulletin No. 18 ("Lobster Investigations in Newfoundland, 1938–1941", by W. Templeman and S. N. Tibbo), bulletins of the Newfoundland Government Laboratory will come to an end, and publication in future will be through the *Journal*, bulletins and other publication channels of the Fisheries Research Board of Canada. The new address of the Laboratory will be the Newfoundland Biological Station, St. John's, Newfoundland. We wish the Station every success under the new regime.

Conference on Civil Engineering Problems in the Colonies

A conference on civil engineering problems in Colonial territories will be held at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, during July 3–7. This is the second such conference to be organised by the Institution, and, following the successful one held at Oxford in 1948, it has been decided to make it a biennial event. These meetings are intended primarily to meet the needs of civil engineers in the Colonial engineering service. The programme consists of technical sessions, when papers are presented and discussed; visits to engineering works; and a reception at the Institution on July 7. One of the technical sessions is being devoted to "Engineering Research and the Colonial Engineer", when short lectures from the directors of the Road Research Laboratory, Forest Products Research Laboratory, Hydraulics Research Organisation, Building Research Station, and the Water Pollution Research Laboratory will be given. It is intended to publish, in due course, the proceedings of the conference, which will contain all the papers and lectures presented, together with the discussions thereon. Attendance at the conference is not limited to members of the Institution of Civil Engineers, and non-members desirous of attending should apply to the secretary of the Institution.

University of London

The title of professor emeritus of zoology in the University of London has been conferred on Prof. A. J. Grove on his retirement from the chair of zoology at Queen Mary College, where he has been an 'appointed teacher' since 1933; the title of professor of pharmacology in the University has been conferred on Dr. J. M. Robson in respect of the post held by him at Guy's Hospital Medical School. Dr. G. Brownlee has been appointed to the University readership in pharmacology, tenable at King's College. The degree of D.Sc. has been conferred on W. Ehrenberg (Birkbeck College) and L. N. Owen (Imperial College of Science and Technology).

Royal Statistical Society: Election of Officers

At the annual general meeting of the Royal Statistical Society the following elections were announced: *President*, Prof. Bradford Hill; *Honorary Secretaries*, Mr. R. F. George, Mr. Richard Stone, Mr. Philip Lyle; *Honorary Treasurer*, Mr. R. F. Fowler. Mr. H. Campion, of the Central Statistical Office, was awarded the Society's Guy Medal in silver.

The Night Sky in July

New moon occurs on July 15d. 05h. 05m., U.T., and full moon on July 29d. 04h. 17m. The following conjunctions with the moon take place: July 4d. 03h., Jupiter 1° N.; July 12d. 12h., Venus 6° S.; July 19d. 08h., Saturn 0·8° N.; July 21d. 18h., Mars 1° N.; July 31d. 09h., Jupiter 0·9° N. Mercury is a morning star at the beginning of the month, but, as it rises only forty minutes before the sun on July 1 and is in superior conjunction on July 11, it is too close to the sun for observation during the month. Venus rises nearly two hours before the sun throughout July and can be seen in the eastern sky in the early morning hours, stellar magnitude −3·4, the visible portion of the illuminated disk varying between 0·805 and 0·882. Mars sets at 23h. 40m., 22h. 55m. and 22h. 05m. on July 1, 15 and 31, respectively, and can be seen in the constellation of Virgo for a short time before sunrise. In the early part of the month it is a little north of δ Virginis, and at the end of the month a little north-east of α Virginis. Jupiter rises at 22h. 55m. and 20h. 55m. on July 1 and 31, respectively, and can be seen about midway between λ and θ Aquarii, but a little south of the line joining them. The declination of the planet is about −9°, so that it does not attain a greater altitude than 30° in the latitude of Greenwich; this maximum altitude is reached in the third week of July about an hour before sunrise, and the planet is too low during the month for very favourable observation. Saturn, which is close to σ Leonis, sets at 23h. 10m. on July 1 and at 22h. 15m. on July 15, but after this it draws too close to the sun for favourable observation, setting 1h. 25m. after the sun on July 31. Only one occultation of stars brighter than magnitude 6 takes place during the month, ω Sagittarii reappearing on July 1d. 02h. 07m. The earth reaches aphelion on July 3.

Announcements

Sir Ian Heilbron, director of the Brewing Industry Research Foundation and formerly professor of organic chemistry in the University of London (Imperial College of Science and Technology), has been elected a foreign member of the Royal Netherlands Academy of Sciences and Letters.

Sir Henry Tizard has asked the Minister of Defence to be relieved of part of his responsibilities as scientific adviser, and will continue work on a part-time basis. Sir Frederick Brundrett, chief of the Royal Naval Scientific Service, has been appointed deputy scientific adviser to the Minister of Defence. Sir Henry Tizard will continue to be chairman of the Defence Research Policy Committee.

The Mixed Commission of Radiobiology, under the auspices of the International Council of Biological Unions, will hold a meeting at the Bibliothèque de l'Institut du Radium, 26 rue d'Ulm, Paris 5e, on July 16, at 5 p.m. The provisional programme will include: the election of a president and a secretary; information and publications on radiobiology; organisation within the United Nations; radiobiological teaching and research; standardization of animal stocks and of biological material; and radiobiological units. This meeting has been made possible by a grant from Unesco. The secretary of the Commission is Dr. P. Bonet-Maury, Laboratoire Curie, 11 rue Pierre-Curie, Paris 5e.

The fifth annual electronics exhibition organised by the North-Western Branch of the Institution of Electronics will be held at the College of Technology, Manchester, on July 18, 2.30 p.m.–9 p.m., and during July 19–20, 10 a.m.–9 p.m. Part of the exhibition will be devoted to the interests of the amateur constructor, and there will be demonstrations of television reception on receivers designed for home construction. Admission will be by ticket obtainable from Mr. A. Hickson, 205 Parrs Wood Road South, East Didsbury, Manchester 20.

A day conference on "Clay Minerals, with Special Reference to Moulding Sand Bonds" will be held in the Department of Coal Gas and Fuel Industries, University of Leeds, on July 7, beginning at 10 a.m. Papers will be given by Dr. R. E. Grim, geologist and head of the Division of Clay Resources and Clay Mineral Technology, State Geological Survey Division, Illinois, and by Prof. A. L. Roberts and Dr. R. W. Grimshaw, of the University of Leeds. The papers will be followed by discussions and demonstrations. Attendance fee for the conference is 10*s*. Further particulars may be obtained from Miss M. Spink, assistant to the Director of Extra-Mural Studies, University, Leeds, 2.

The Medical Research Council invites applications for the Kathleen Schlesinger Fellowship, tenable initially for one year at the National Hospital for Diseases of the Nervous System, Queen Square, London, and worth £700–£1,000 a year. This fellowship is provided from a fund established by the late Mr. E. M. Schlesinger and Mrs. Schlesinger in memory of their daughter; it is for the investigation of the origin and nature of cysts of the brain, and preference will be given to candidates who elect to work on the mechanisms underlying degenerative processes affecting the brain. Applications must reach the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, not later than July 15.

Erratum. In *Nature* of June 3, p. 868, in a notice of "Biology and Man", it is stated that the author is senior biology master at Winchester College; Dr. F. G. W. Knowles is, in fact, senior biology master at Marlborough College.

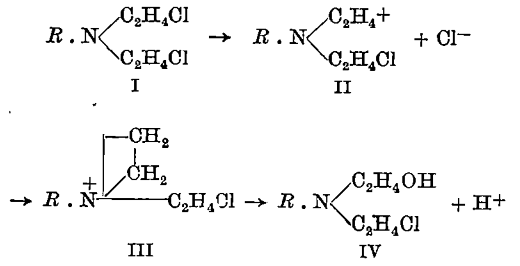
NATURE OF NUCLEOTOXIC SUBSTANCES

By Dr. J. A. V. BUTLER

Chester Beatty Research Institute, Royal Cancer Hospital, London

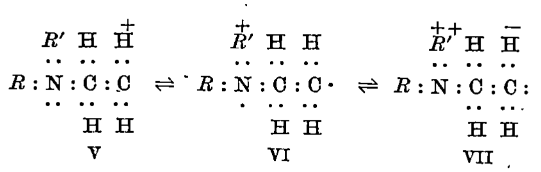
THE close similarity of the actions on deoxyribonucleic acid of nitrogen and sulphur 'mustards' with those of free hydroxyl radicals, which has been described in earlier articles[1], naturally leads one to inquire what feature they have in common. It is difficult to find a plausible mechanism, which has any support in the observed reactions of these substances, which would yield simple free radicals like H and OH.

It has occurred to me that the answer may be that the immediate reaction products of these compounds with water may themselves possess free radical properties. The course of the first-stage hydrolysis, for example, of compound I, may be represented by the following sequence of reactions[2]:



The evidence on which this is based is: (1) the appearance of Cl^- in the solution prior to the liberation of an equivalent amount of H^+; (2) the subsequent liberation of H^+; (3) the instantaneous reaction of the postulated stable intermediate III with thiosulphate.

All these facts can be equally well explained if the intermediate remains at least partially in the non-cyclic forms, in which stabilization might occur by resonance between several possible structures, which can be represented as:



The existence of such forms easily explains the well-known dimerization reactions[3] and the condensation reactions with such molecules as cysteine, methionine, hexamethylene tetramine and pyridine, which occur so readily[4]. A resonance hybrid of this kind has been suggested for ethylene oxide and similar molecules[5].

Electron displacements of the type V → VII, in which the electrons of a lone pair are donated to an appropriate acceptor atom, have been suggested[5] to account for a number of different types of organic rearrangements; for example:

$$R_3N + CH_3 . Br \rightarrow R_3\overset{+}{N} . CH_3 + Br^-.$$

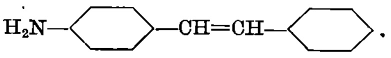
It is to be expected that the carbonium ion in V will act as a powerful acceptor. Form VI is potentially a double radical and to it the radical-simulating properties may be due.

Everett and Ross[6] have shown that when R in (I) is an aromatic substituent, the Cl^- and H^+ are liberated together, so that there is in these cases no evidence of any long-lived intermediates between I and IV. This must be regarded as evidence of the lesser stability of form VI; but the biradical form may be present to a sufficient extent to influence the reactivity. It may be significant that the toxicity of these compounds is relatively low.

It has been shown that in these compounds and in the sulphur analogues two halogen groups are normally necessary to produce biological activity. This has been interpreted in various ways, such as the ability of the two-armed halides to act as cross-linking agents[7]. The above considerations suggest that the function of the second halogen atom may be to assist in stabilizing the 'radical' form VI. It may do this by reducing the binding energy of electrons in the central nitrogen or sulphur atom, so that an electron can be more readily donated to the terminal carbonium or by giving rise to additional resonance possibilities.

On the view suggested, the occurrence of radical-like forms in these compounds would depend primarily on the relative strengths of the electron bindings in the various structures. It would follow from this, however, that *two* halide groups may not be invariably necessary for the appearance of this behaviour, if the energy requirements can be met in other ways.

It is interesting to note that most of the known nucleotoxic substances can give rise to similar structures; but it must be emphasized that their occurrence and stability will depend on the energy relationships and not merely on the formal possibilities. Any double bond might be 'activated' in this way; whether it is depends on the nature of the molecular orbitals and the electron densities produced around the different atoms. For example, in the case of 4-amino-stilbene, it has been shown by Coulson and Jacobs[8] that the charge distribution in the double bond is markedly asymmetric "resulting in reduced bonding and a greater proportion of the electrons free to initiate reactions". Also it has been suggested by Daudel[9] and by Mme. Pullman[10] that there is in the polycyclic hydrocarbons a region of high electron density termed by them the *K*-region, to which they ascribe the carcinogenic properties of these compounds; the biological activity is correlated by them with a certain optimum value of the electron density. (According to the calculations, this concentration is unequally distributed between the two active atoms.)

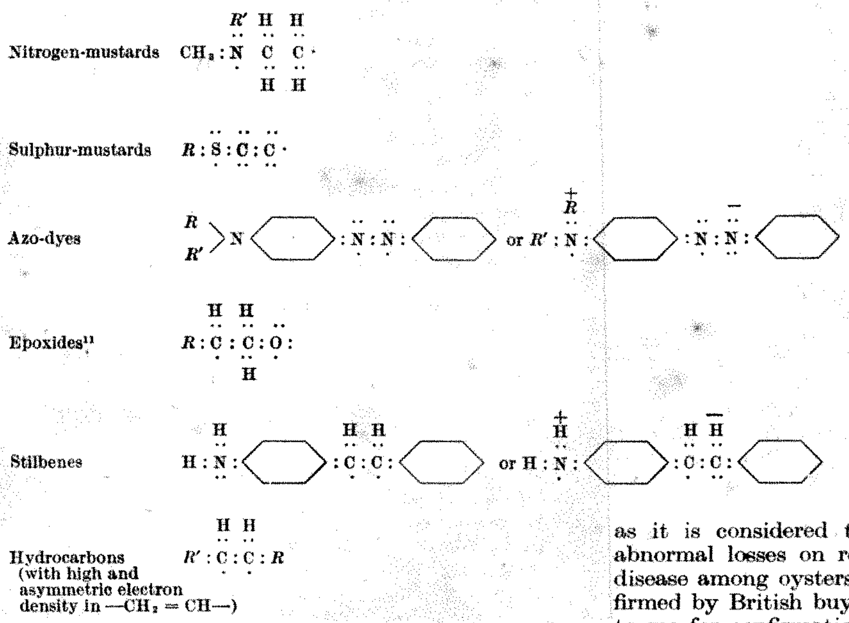


The essence of the requirement may be its asymmetry, resulting in potential radical forms in the region in question.

The accompanying list shows the crude conventional formulations of most of the types of compounds in which nucleotoxic properties of various kinds (either carcinogenicity, or mutagenic properties, or both) have been reported. It can be seen that they are all capable of biradical formulation. The actual structures will be hybrids of the possible forms, and the prominence of radical-like properties and reactivity will depend on the energy relations and particularly on the symmetry of the molecules. It must also be noted that other biradical forms are possible; for example, in the azo-dyes the amino-nitrogen has a lone pair of electrons, of which one might be donated to the diazo-group. These possibilities could only be distinguished by a very exact knowledge of the molecular structures.

As a final illustration, we may observe that, according to the theories of colour and fluorescence proposed by G. N. Lewis, all molecules with double bonds have excited states in which one of the double bonds is broken. It is suggested that these states are biradicals with one pair of electrons having parallel spins[12]. In support of this it has been shown that fluorescein when irradiated with blue light becomes paramagnetic[13]. It is therefore of interest to find that G. Oster has observed[14] that *ribonucleic* acid is degraded by blue light, in the presence of the fluorescent dye, acriflavine, and tobacco mosaic virus is also inactivated by this treatment. This may be regarded as a confirmation of the nucleotoxic effect of biradicals formed by irradiation.

BIRADICAL FORMS OF SUBSTANCES WITH VARIOUS NUCLEOTOXIC PROPERTIES


Nitrogen-mustards
Sulphur-mustards
Azo-dyes
Epoxides[11]
Stilbenes
Hydrocarbons (with high and asymmetric electron density in —CH₂ = CH—)

This and the previous investigation have been assisted by grants to the Royal Cancer Hospital from the British Empire Cancer Campaign, the Jane Coffin Childs Fund for Medical Research, the Anna Fuller Fund and the Division of Research Grants of the U.S. Public Health Service.

I am also greatly indebted to Profs. A. Haddow and G. A. R. Kon, and to Dr. W. C. J. Ross, for discussions which have helped me to clarify some of the points mentioned above.

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SHELL DISEASE IN RE-LAID FRENCH OYSTERS

By DR. H. A. COLE

Fisheries Experiment Station, Conway, Caernarvonshire

SHELL disease in oysters has been prevalent in the Netherlands for many years and was the cause of serious mortalities in the years following 1930[1]. A full account of this disease has never been published; but at the special shellfish meeting of the International Council for the Exploration of the Sea, held at Edinburgh in October 1949, Dr. P. Korringa presented a paper giving a summary of his work and brief details of the method of control now employed in the Netherlands.

In this paper, and in private communications, Korringa states that he has several times observed undoubted shell disease, identical with that occurring in the Netherlands, in French oysters offered for sale by planters in Brittany. Great care is apparently taken by Dutch importers to avoid the purchase of such infected stocks, as it is considered that the disease may lead to abnormal losses on relaying. The presence of this disease among oysters in Brittany was recently confirmed by British buyers, the shells being submitted to me for confirmation.

Giard[2], Hornell[3] and Ranson[4] have recorded the existence of a disease among French oysters, commonly referred to as 'maladie du pied', which appears to be similar in its effects to Dutch shell disease. Further investigations may show that they are identical. Orton[5], on the other hand, in a review of the literature, concluded that the disease 'maladie du pied' could not be clearly defined, and that the

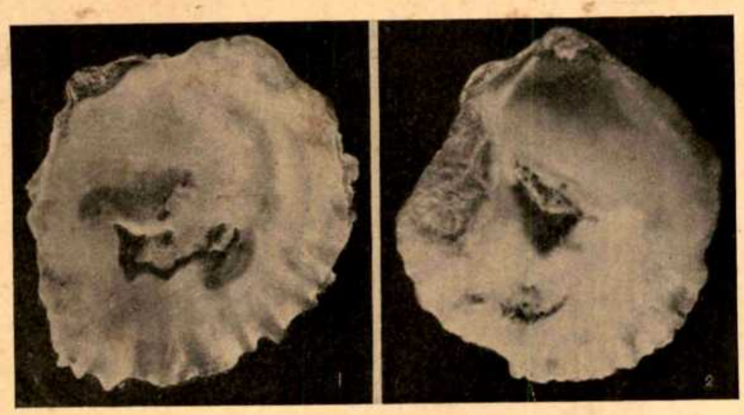

Fig. 1. The disease invading the area of muscle attachment
Fig. 2. The muscle scar very seriously affected and the shell margin distorted

published accounts would not bear critical examination. Judging by the literature, 'maladie du pied', although widely observed among stocks of French oysters, does not usually cause serious losses.

There is no record of the occurrence of shell disease in Britain. Orton, after an exhaustive examination of diseased, or alleged diseased, oysters from practically all the oyster beds of commercial importance in Britain, found that brown 'excretory deposits' were of rather frequent occurrence on the shell of both weak and normal oysters. He concluded that they were of little importance.

During the course of the past fifteen years, I have opened and examined, for a variety of purposes, many thousands of oysters from all parts of Britain, including substantial quantities of re-laid French oysters, but not until recently had I been able to detect with certainty the presence of shell disease. On December 5, 1949, of fifty re-laid French oysters taken from the Menai Straits oysterage, two showed advanced shell disease, in each case affecting the shell beneath the adductor muscle; the cupped valve of one of these oysters is shown in Fig. 1. The consignment of oysters, from which these fifty were a random selection, was laid down direct from France in April 1949 in the region of low water of spring tides. A second sample of fifty, collected on December 21 from the same bed, yielded two with undoubted shell disease and a third suspect; one of the affected oysters was in very poor condition.

A further example of shell disease was found on December 13 by an oyster planter when examining some weak or dead oysters thrown out from various consignments received at the London depot of the company. In this case the oyster was gaping and the shell and adductor muscle were very severely affected; the cupped valve is shown in Fig. 2. As oysters are received at this depot from various beds in Cornwall, Kent and Essex, it was impossible to say with certainty from which area it was received, but it was undoubtedly a French oyster imported and re-laid in 1949.

I have since examined samples of French oysters, imported last year, from all the more important centres of oyster culture in Great Britain. The percentage showing shell disease varied between 4 and 30, but shells with the disease in an advanced stage were not common.

Such seriously diseased oysters cannot have been frequent among imported stocks in past years, for they would have been reported earlier. Further, close examinations (for another purpose) of the 'clocks' of many recently dead re-laid French oysters from our beds in the Roach River, Essex, have been made from time to time without disclosing any so seriously affected by shell disease as to be noticeable. A recent careful examination of native brood oysters and spat from a ground in the River Roach, on which French oysters have been laid thickly for two years, did not reveal any evidence of shell disease.

On our Menai Straits grounds, and in the Helford River, Cornwall, and probably elsewhere, many oysters may be found with dendritic white markings in the shell, usually in both valves, which simulate the early stages of shell disease. These markings, which are probably the result of infection by a fungus related to that causing shell disease, have never been known to lead to any serious after-effects, loss of condition, or mortality. Dutch shell disease, on the other hand, disfigures the inside of the shell by the production of extensive brown patches and warts, and leads to serious loss of condition, and, ultimately, death, when the disease reaches the muscle attachment.

French oysters, presumably including a proportion affected by shell disease, have been laid down on British beds in large quantities during the past fifteen years, and have, generally speaking, done very well and proved of great value for re-stocking depleted grounds. The occurrence this season of noticeable shell disease, with the serious secondary effects on the shell and adductor muscle, suggests that the British buyers were unlucky to include among their purchases in 1949 some heavily infected oysters. Korringa's investigations have shown that the disease spreads rapidly in hot summers, and the oysters imported in 1949 were presumably affected in the warm summer of 1947. The reported heavy production and consequent overcrowding on Brittany oyster beds may also be a contributory factor.

The exceptionally hot summer of 1949 may have led to a further spread of the disease in Brittany, and the effect of this will be noticeable in 1951 when the young oysters infected in 1949 reach a saleable size. Particularly careful examination of stocks offered for sale will therefore be necessary during the next few years.

Previous experience suggests that there is little likelihood of Dutch shell disease spreading on British beds from the comparatively small numbers of seriously infected oysters now present; but clearly every care should be taken in future to avoid the importation of diseased stock. The progress of the disease on British beds should be carefully observed.

In presenting this note I am much indebted to Dr. P. Korringa, Bergen-op-Zoom, for confirming my diagnosis of shell disease, and for much helpful information and correspondence.

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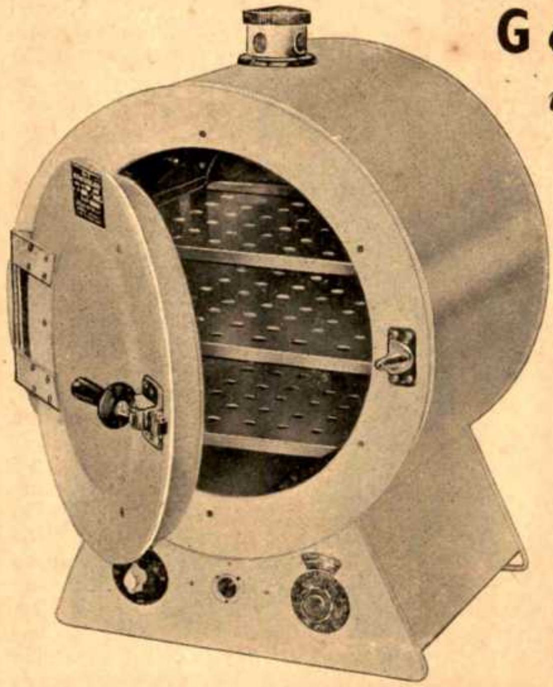

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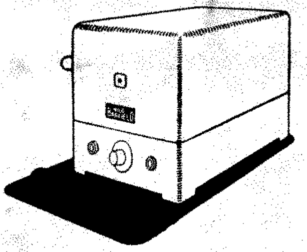

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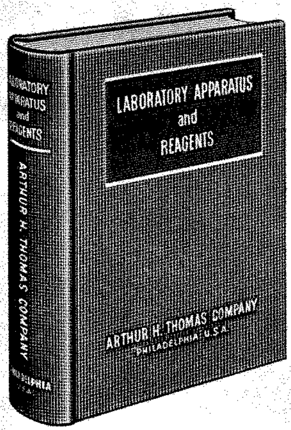

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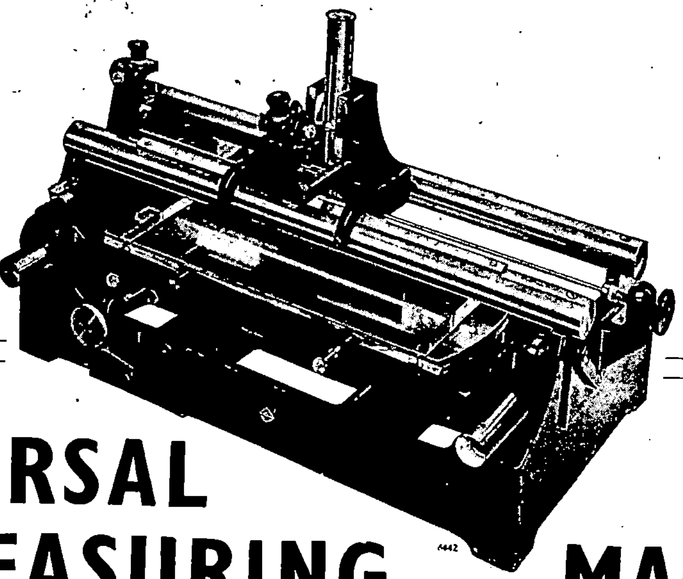

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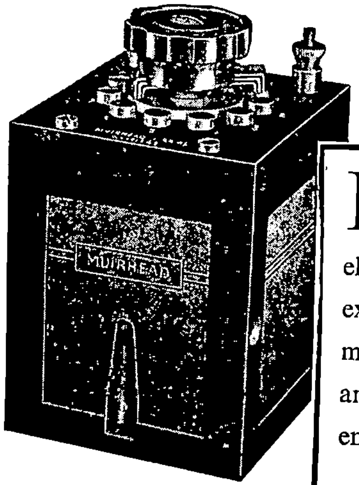

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GAUSSIAN APPROXIMATIONS TO WAVE FUNCTIONS

By DR. R. McWEENY

Chemistry Dept., King's College, University of Durham, Newcastle upon Tyne

IN a recent paper[1], Boys proposes a general method of building up variational approximations to atomic and molecular wave functions from the members of a "complete class of Gaussian functions". Some time ago I made an independent investigation along somewhat similar lines[2], and it is the purpose of this communication to examine briefly the whole approach in the light of experience gained in this previous work.

Boys takes as his basic system the class of functions $\{x^l y^m z^n \exp(-a r_A^2)\}$, where

$$r_A^2 = (x-X_A)^2 + (y-Y_A)^2 + (z-Z_A)^2,$$

A being a variable point in space, l, m, n any integers, and a a variable parameter. Such a class contains an infinite number of complete Hermitian systems about every point A. Boys then forms "detors", that is, antisymmetrized products of ortho-normal one-electron functions formed from this class, each combined with a spin function. A large number of such detors would effectively span the entire representation space of the n-electron problem; but in practice, of course, the number used must be severely restricted by careful selection. In fact, hitherto, it has usually been the custom, when using more conventional function systems, to employ only one detor or, when configurational degeneracy exists, a small number of detors: the approximate eigenvector resulting from a variation treatment is then necessarily of limited accuracy, being confined to a certain subspace of the complete n-electron product space. The possibility of proceeding more generally has usually been regarded as prohibited, when the detors are based on hydrogen-like one-electron functions, by the difficulty of evaluating matrix elements of the Hamiltonian between such detors; this difficulty is removed if the one-electron functions are written in Gaussian form, all integrals involved then being expressible in relatively simple terms. It thus appears feasible that one might construct wave functions of great accuracy by applying the usual variation treatment to a linear combination of suitably chosen Gaussian detors.

Briefly, the novelty of the method arises from the particular choice of function system: it gives great liberty in selecting suitable functions, and it makes possible the use of more detors than usual by circumventing integration difficulties. No application of this general method has yet been published. In a treatment of the beryllium atom[3], it is possible to use detors based on hydrogen-like functions; but since, with suitable screening constants, these are already particularly good basic approximations, the difficulty of making a good selection of functions is evaded.

In constructing molecular wave functions it is impossible to make progress by this method unless one uses Gaussian functions. Our work has much in common with that of Boys, except that the whole problem was formulated and discussed in momentum space. Our conclusion was that, in spite of the elegance of the method, its ultimate value is doubtful simply because the Gaussian function is an appallingly bad substitute for the hydrogen-like function, from which detors would ideally be constructed. It will, however, be of great interest to see how far the method can be pressed; we shall therefore briefly present certain of our results. Using Gaussian functions, the choice of the most satisfactory members of the set proves to be both critical and difficult; the selection technique therefore becomes vital to the whole method if, as indeed is essential, the number of basic functions is to be reduced to a minimum.

Since our calculations were performed throughout in momentum space, it is first necessary to point out that the one-electron wave function $\psi(\mathbf{r})$ in co-ordinate space and the corresponding $\chi(\mathbf{p})$ in momentum space are identical in form provided this form is Gaussian; for Fourier transformation of such a function simply produces a similar function with different parameters. This means that a Gaussian wave function would, for some purposes, be of great practical utility owing to its simple transformation properties. (Usually it is impossible to obtain a momentum distribution function from an *accurate* co-ordinate space wave function[4,5].)

The eigen value equation for the bound states of one particle in an arbitrary central field can be solved fairly easily in momentum space[2] to any degree of accuracy, using a Gaussian variation function. As in co-ordinate space, the variation treatment involves calculating diagonal matrix elements of the kinetic and potential energy operators with a variation function $\chi(\mathbf{p})$; we shall denote these by $\overline{T}$, $\overline{V}$. It is usually possible to represent the general potential (V) adequately as a combination of a few terms of Gaussian (V_G), and Yukawa ($V_Y = (\exp-\varkappa r)/r$) (including Coulombic) form. Taking the basic Gaussian term as $V_G = \left(\frac{\pi}{t}\right)^{3/2} \exp\left(-\frac{r^2}{4t}\right)$, and defining the integral operator

$$I(t,x) = \int_0^\infty dt \exp(-x^2 t) \ldots,$$

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it is readily shown that $\overline{V}$ may be obtained easily from $\overline{V}_G$, for $\overline{V}_Y = (2\pi^2)^{-1} I(t,\varkappa) \overline{V}_G$: moreover, with a Gaussian variation function both $\overline{T}$ and $\overline{V}_G$ are elementary integrals.

Here then is a simple method by which one-particle wave functions for various fields may be determined directly in Gaussian form; the method has been applied to the deuteron[6], using the Yukawa potential, and to other problems, including the hydrogen-like atom[2]. This latter application gives a first indication of which functions should be selected in building up Gaussian detors in the more general n-electron problem. With this type of problem in mind, the following general conclusions and numerical illustrations (contained in ref. 2 and in further unpublished work) may be of considerable value. In essence our task is to find how successfully one can replace hydrogen-like atomic orbitals by combinations of Gaussian terms, experience having shown beyond all doubt that the former are eminently suitable as basic approximations.

(i) In building up wave functions by linear combination of the members of the complete Gaussian class, it is most advantageous to select the members from *different* Hermite sets. With one electron, for example, the detors reduce to single terms, and for an atomic ($1s$) state there are two extreme types of selection

$$\psi(1s) = \rho_1 \exp(-\alpha r^2) + \rho_2 r^2 \exp(-\alpha r^2) + \ldots \quad (1)$$

where every term is included within one single Hermite set, and

$$\psi(1s) = \rho_1 \exp(-\alpha r^2) + \rho_2 \exp(-2\alpha r^2) + \ldots \quad (2)$$

where every term is chosen from a different set.

As the number of terms is increased, (1) is found to converge extremely slowly towards the true solution; on the other hand, (2) converges rapidly, and even two terms can give quite a fair approximation. The reason for this difference is bound up with the asymptotic behaviour of the exact function in momentum space: for large p, this behaves like $1/p^4$, while all terms of (1) behave like $\exp(-Sp^2)$. By taking terms from *different* Hermite sets, however, it is possible to correct this asymptotic failure relatively easily. Indeed, quite a small number of terms can give an excellent approximation to the exact solution over the significant range of p values (cf. ref. 6).

(ii) It is not generally practicable to make the best possible selection of functions of given type, for too many features are variable. If the number of terms is restricted to two or three, however, one can make this best choice by a rigorous variation treatment. The following results were obtained in this way, using two-term functions in dealing with the ($1s$) and ($2p$) states of a hydrogen-like atom. The functions employed were:

$$\begin{array}{ll} \text{Momentum space} & \left\{ \begin{array}{l} \chi(1s) = \exp(-Sp^2) + \mu \exp(-sSp^2) \\ \chi(2p) = \mathbf{c}\cdot\mathbf{p}[\exp(-S p^2) + \\ \qquad\qquad \mu' \exp(-s'S'p^2)] \end{array} \right. \\ \text{Co-ordinate space} & \left\{ \begin{array}{l} \psi(1s) = \exp(-\alpha r^2) + \rho \exp(-t\alpha r^2) \\ \psi(2p) = \mathbf{c}\cdot\mathbf{r}[\exp(-\alpha r^2) + \\ \qquad\qquad \rho' \exp(-t'\alpha' r^2)] \end{array} \right. \end{array}$$

where

$$\alpha = 1/4S,\ \rho = \mu/s^{3/2},\ t = 1/s$$
$$\alpha' = 1/4S',\ \rho = \mu'/s'^{5/2},\ t' = 1/s'.$$

In each case **c** is a constant unit vector and the functions are not normalized. Best values of the constants are found to be (using atomic units)

$$s = 6{\cdot}6,\ \mu = 12{\cdot}3,\ S = 0{\cdot}188{,}02/Z^2$$
$$s' = 4{\cdot}6,\ \mu' = 17{\cdot}8,\ S' = 1{\cdot}653{,}5/Z^2,$$

where Z is the nuclear charge. S and μ are thus characteristic of the *type* of function to which we approximate and are conveniently regarded as fixed constants. The one remaining parameter S provides a function of flexibility roughly equivalent to that of the conventional screening-constant wave function. The energy values calculated from these functions are compared below with those obtained using one-term functions.

	1 term	2 term	Error (per cent)
E ($1s$) (atomic units)	$-0{\cdot}424{,}42\ Z^2$	$-0{\cdot}485{,}82\ Z^2$	2·84
E ($2p$) (atomic units)	$-0{\cdot}113{,}18\ Z^2$	$-0{\cdot}123{,}24\ Z^3$	1·34

The single-term approximation is obviously very bad in each case; but the removal of 82 per cent and 85 per cent of the respective residual errors by inclusion of a second term is quite remarkable. This is encouraging, but unless subsequent terms are selected with comparable care the rapid convergence is not continued; it is this necessity for careful selection which seems to constitute one of the most serious obstacles to progress.

(iii) Using a limited number of terms, we have made preliminary investigations of He and H_2^+. As expected, only one parameter is sensitive to effective nuclear charge. Rough basic functions of Gaussian type may thus be written down for any problem in terms of the effective nuclear charges of screening constant theory, using the results of (ii) (which may, of course, be extended to include higher states).

Whether further progress will prove possible remains to be seen; our experience suggests that in any particular molecular problem the number of detors necessary is likely to become enormously large.

[1] Boys, *Proc. Roy. Soc.*, A, **200**, 542 (1950).
[2] McWeeny, Dissertation, Oxford (1948).
[3] Boys, *Proc. Roy. Soc.*, A, **201**, 125 (1950).
[4] Duncanson, *Proc. Camb. Phil. Soc.*, **37**, 397 (1941).
[5] McWeeny and Coulson, *Proc. Phys. Soc.*, A, **52**, 509 (1949).
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TURF AND GREENKEEPING

ST. IVES RESEARCH STATION

THE St. Ives Research Station, at Bingley, Yorkshire, of the Board of Greenkeeping Research may be said to have started its active investigational and advisory work on June 1, 1929, and the twenty-first anniversary of the Station is to be marked by a three-day conference in mid-September, under the chairmanship of Lord Brabazon of Tara. On that occasion the experimental ground will be open, by invitation, to representatives of sports clubs, when there will be demonstrations of turf experiments in progress, an exhibit showing the history and development of the Station and a display of present-day equipment used in turf production.

The credit of suggesting that turf, as distinct from grassland, should form the subject of scientific investigation rightly belongs to the Green Committee of the Royal and Ancient Golf Club of St. Andrews, which, in May 1924, convened a meeting of representatives of golf clubs in Great Britain and Ireland for the purpose of exploring the matter and devising a programme. It was unanimously decided to proceed further by setting up a scientific committee under the chairmanship of the late Sir Robert Greig, then secretary to the Department of Agriculture for Scotland. This committee prepared a scheme of research; but the result of an appeal for financial support was insufficient to warrant a start at that time, and the matter was left in abeyance. In the autumn of 1926, however, the Green Committee of the Royal and Ancient Golf Club approached the British Golf Unions' Joint Advisory Council (a body elected annually by the four national golf unions) and asked if it would take up the question of turf research. The Council agreed, and after careful inquiry, assisted by Sir Robert Greig, a comprehensive scheme was prepared. This involved a guaranteed income for five years, each national golf union being responsible for raising a quota based on the number of courses used by affiliated clubs. The response to this new scheme was wholehearted, and in February 1929 the Board of Greenkeeping Research was set up by resolution of the Joint Advisory Council.

Following this, it was necessary to choose a site, and eventually the St. Ives estate, Bingley, Yorkshire, was chosen; accommodation for laboratories and offices with some five acres of adjacent land being leased. The preparatory work on the new Station began in June 1929, and within a few years the lease was extended to cover additional rooms and an area of land amounting to twenty acres, while the staff grew to some twenty-five in number. These years also saw an awakening of interest in the work of the Station by bowling, cricket, football and other clubs.

The story of the Station really falls into four chapters: the pre-history period (already referred to) during 1924–29 when initial support was being obtained; the period of early growth, 1929–39, when much preliminary investigation was done; the war period, 1939–45, when the activities were maintained on a nucleus basis; and finally the fourth period, 1945–50, during which a full programme of research was restored. This period has been conspicuous by the ever-growing interest and enthusiasm of clubs other than golf which are equally desirous of improving the standard of their turf and benefiting from the results of the scientific work of the Station. Steadily increasing support has been forthcoming from such quarters as football clubs, bowling clubs, general sports clubs, industrial welfare clubs, public authorities, education committees, as well as some of the larger sports associations.

The management of the Station is in the hands of the Board (appointed annually by the Joint Advisory Council), which is supported by a Scientific Advisory Committee as well as a Practical Advisory Committee composed of greenkeepers and groundsmen. The system of quotas from the national golf unions has continued, but with a fifty per cent increase since the War.

At all times during its twenty-one years of existence, development at the Research Station has been restricted by the smallness of the income. Nevertheless, by careful budgeting and modest spending, steady progress has been made, and, although the income rose steadily from £2,140 in 1930, it had only reached a figure of a little more than £10,000 in 1949. The Board has at no time been in receipt of any State grant, but has built up its reputation and assets by means of contributions made to research by sports clubs, associations and other interested persons and bodies. These voluntary contributions have all been at a low level; but, as they confer a right to a postal advisory service, there is a marked tendency for the subscriber to regard his contribution as being paid for direct services and not for research. Consequently, the advisory services tend to overshadow research activities. The income of the Station is not entirely derived from subscriptions, but is supplemented by fees earned by advisory officers carrying out personal visits to sports grounds. The Board is responsible for a volume of work and service not elsewhere available, and the Station is one of the very few receiving no State grant. It is independent and non-profit-making, the members of the management committee receiving no payment for their services.

It may be well at this point to refer briefly to the experimental work. Most of this has been done at Bingley; but outside experiments dealing with specific problems (for example, control of leather jackets) have been done on actual sports grounds and golf courses as occasion demanded. The experimental ground at the Station is laid out in groupings of plots devoted to specific inquiries, primarily applied or practical, and some fifteen hundred turf plots are at present under observation. Many subjects have been investigated during the twenty-one years, but the first experimental plots to be put down in 1929 are still in existence. They comprise single-species sowings and simple mixtures upon which are superimposed comparative manurial treatments. This series has been maintained (on parallel lines to Park Grass, Rothamsted, but under putting-green conditions), without major alterations in management. This long-range experiment has provided much information on the influence of manures on weed and earthworm invasion, upon resiliency of turf, relation of quality to soil reaction, and upon susceptibility to disease. It is clear from this and other experiments that the desirable grasses for dwarf swards (species of *Festuca* and *Agrostis*) do not require high fertility or alkaline soil conditions. Mowing is a factor of major importance in determining species in a turf, since mowing—unlike grazing—is entirely non-selective.

In fine-turf cultivation earthworm activity can be a serious detriment, and much time has been devoted to trials with promising eradicants, with the result that lead arsenate, permanganate of potash and derris have been added to the list. The search for cheaper and more efficient materials continues.

Undoubtedly the most serious problem in turf upkeep is the prevention or eradication of weeds, and throughout the history of the Station work has been devoted to this aspect. Early work was mainly concerned with the influence of ammonium sulphate and other ammonium salts with or without the addition of ferrous sulphate. Later, attention was turned to selective spraying with dilute solutions of arsenic acid. Since the War, however, work has been concentrated on growth-regulating substances. In fact, much of the information available to-day is based on the plot experiments at Bingley. This work has aimed at ascertaining the relative susceptibility of weed species, while optimum rates have been worked out for the sodium and amine salts as well as the esters of M.C.P.A. and D.C.P.A.

So far as insect pests are concerned, perhaps the most serious and widespread is the leather jacket (larvæ of Tipulids), it being quite common to find infestations in the order of 500–1,000 per square yard. Earlier work showed *ortho*dichlorobenzene to be a useful expellent, while later investigations proved the value of lead arsenate. More recently, however, following upon the post-war work of the Station, both DDT and 'Gammexane' have been widely adopted in practice.

Under conditions of high nitrogen fertility combined with a high level of cultivation, mown swards become susceptible to certain fungal diseases, notably *Fusarium* patch. Here again, investigations have provided data on control; but the search for more efficient fungicides continues.

There is a marked tendency among those responsible for turf management to think only in terms of mowing and occasional applications of fertilizer; but pre-war work, more fully substantiated later, has clearly shown the importance of mechanical operations like raking, harrowing and spiking. There is an ever-present tendency where turf is growing under acid soil conditions for the *Agrostis*, in particular, to form a surface mat and for the grass to be short-rooted and of low drought resistance. The penetration of this mat by forking and spiking has been proved to give stronger root development, better moisture penetration and better drought resistance with more rapid recovery after drought. The findings at the Station on this side of turf upkeep have been largely instrumental in the development of suitable machinery for treating both small and large areas. Indeed, throughout its history the Station has consistently encouraged implement makers to bring prototypes and final models to the Station for trial and constructive criticism. So important is the machinery side considered, whether it be for mowing, aeration or any other purpose, that the Board has set up at the Station a permanent implement exhibition where up-to-date tackle can be suitably displayed, while provision has been made for practical demonstrations.

Several other lines of work remain to be briefly mentioned: first, a study of grass strains, leading to the selection of several improved types of *Agrostis* and fescue, a study of seed establishment and of seed mixtures for various purposes, together with the most practical methods of sowing; secondly, the establishment of new swards from sods; and thirdly, studies on the importance of top-dressing closely mown swards with finely prepared composts and sand. Linked to this there are experiments on bitument treatment of new-sown and established swards.

Most of the lines of investigation briefly outlined above, together with some others, are continuing in one form or another. The aim throughout is to provide information that can be disseminated through the advisory service. It may not be without interest to record that in the past year 942 advisory visits were carried out to sports clubs and golf clubs throughout Great Britain and Ireland (with some on the Continent of Europe), while 8,343 advisory letters were sent through the post. The advice given is supported by soil analyses in the laboratory which, together with past experience and the growing fund of information derived from the experimental work, enable the advisory officers to tender advice at a high level of efficiency.

A feature of the work at the Station has been the development of the educational side. Courses of instruction in the science and practice of turf upkeep are now held at intervals. They cover one week, and groundsmen and greenkeepers receive an intensive course of lectures and practical work. Extension work involves a range from lectures to groundsmen's and greenkeepers' associations throughout Great Britain to the preparation of articles on turf matters and to the issue of the Board's *Journal* each year. There have been twenty-five issues of this, three being since the War.

The Station at the moment is extending, although such growth is at present handicapped by lack of further accommodation; but, if the necessary capital were available, this handicap could be overcome. Future development envisages a continual widening of the advisory service by adding still more clubs to the ever-growing list of subscribers, on which are numbered already many of the foremost cricket, football, bowling and other clubs. It is probable that the demand for courses of instruction in turf upkeep will grow, and the experiment of holding an evening course in the Midlands is to be tried out next winter.

Not only is it likely that a greater measure of support will be forthcoming from individual sports clubs, but also the moral and eventual financial backing of the ruling bodies governing each particular sport may be confidently expected. The provision of development funds would enable the Station to emerge before its silver jubilee as a truly national turf research centre concentrating upon what is undoubtedly the most important asset of the great 'industry of sport'.

HEALTH TEACHING IN THE UNIVERSITY

IN a recent issue of the *Health Education Journal* (8, No. 2; April 1950), Prof. F. C. Thomson, of the School of Public Health, University of Minnesota, describes the courses in health which are being given in the University. Teaching of general courses in health is one of the functions and responsibilities of the School of Public Health, and these have been designed for students who desire some knowledge of personal health and an understanding of the problems of community health. The course in 'personal health' is offered four times during the three terms of the academic year. In several colleges of the University this general course in personal health or an acceptable substitute must be taken before graduation. In certain of the colleges a student may be exempted from this course if he passes an examination prepared by the staff of the School of Public Health; but the number exempted is small. Examples of the topics dealt with during one term are: understanding ourselves as living organisms; certain essentials for health; nutritional needs; safe milk, water and food supplies; digestive disturbances; prevention and care of respiratory disorders; auditory and visual problems; dental health; common skin diseases; protection against communicable diseases; important health problems of the present day (heart disease, cancer, tuberculosis, etc.); accident prevention; endocrines; reproductive system; venereal diseases; health of the mother and child; mental health; alcoholism and narcotic addiction; personal health as a part of community health; facilities for medical care; health agencies.

The introductory course in community health is open to students who have shown that they have an adequate knowledge of personal problems, the general plan being similar to that for the personal health course. The subjects discussed include: origin and growth of the community's interest in health; spread of communicable diseases from man to man; diseases of animals transmitted to man; arthropods and the spread of disease; community programmes in the control of communicable diseases; healthful housing; safe water for rural and urban communities; sewage treatment and refuse disposal; maintaining barriers against food-borne diseases; community problems in mental hygiene; attacking the problem of venereal disease; community programmes in the control of heart disease, cancer, diabetes and tuberculosis; safeguarding maternal and child health; health protection and promotion in the schools; care of handicapped individuals; nutritional deficiencies; health maintenance in industry; community safety programmes; community participation for health education; official tax-supported health agencies; voluntary health agencies; analysing the morbidity and mortality records of a community.

There is evidence that the courses are much appreciated by students and put to practical use in their subsequent careers.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

New Techniques in Autoradiography

THE recent communication of Winteringham[1] has focused attention on the two main difficulties which limit the value of the autoradiographic method in the study of the distribution of soluble radioisotopes of short half-life. These two problems, that of preparing the tissue without loss of the soluble tracer, and the enormous radiation intensities needed for a successful exposure, have been largely solved in our work; and in view of the general usefulness of the methods employed, a preliminary publication of their essential features may not be out of place.

The preparation of the specimens is carried out by the freeze-drying method; the apparatus used is essentially the same in design as that described by Gersh[2]. A central chamber, connected through a phosphorus pentoxide drying-tube to a mercury diffusion pump, is surrounded by a Dewar-insulated cooling jacket. The cooling jacket is itself linked with a second (rotary) vacuum pump so that it can be maintained at any desired pressure below the atmospheric level. Cooling is carried out by the use of liquid methyl chloride, which is available in gas cylinders from any firm of refrigeration engineers. Methyl chloride is perfectly safe for use in an open laboratory; it can be blown from the storage cylinder into an ordinary 'Thermos' flask and poured into the cooling jacket through a tin funnel. Its boiling point is − 20° C. at atmospheric pressure; under about 350 mm. pressure it boils at − 50° C., a temperature which we have found generally useful for the freeze-drying process. One filling of the jacket will suffice for forty-eight hours, by which time drying of a small specimen is usually complete.

Before starting work on a specimen, a layer of molten paraffin wax of suitable melting point is poured into the bottom of the central chamber and, while still liquid, is 'de-gassed' under a few millimetres pressure in the main vacuum line. The wax is then allowed to solidify and the methyl chloride poured into the cooling jacket. The specimens, placed on copper trays, are frozen in *iso*pentane cooled in liquid nitrogen, and are immediately transferred to the drying chamber, which is then evacuated.

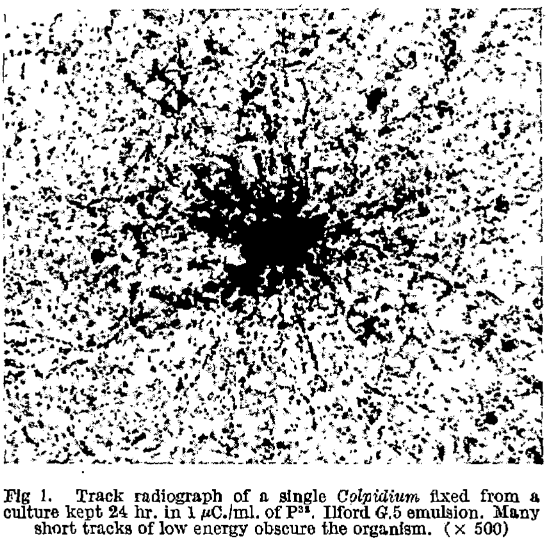

Fig 1. Track radiograph of a single *Colpidium* fixed from a culture kept 24 hr. in 1 μC./ml. of P^{32}. Ilford *G*.5 emulsion. Many short tracks of low energy obscure the organism. (× 500)

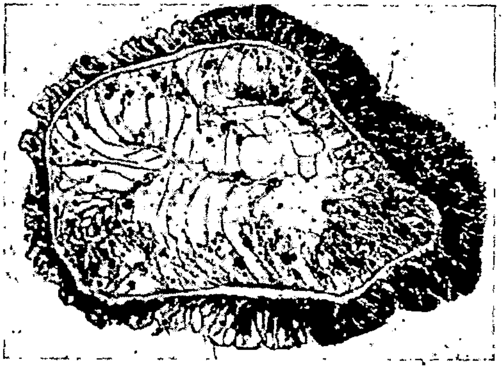

Fig. 2. Transverse section of the base of a tentacle of *Hydra*, fixed by the freeze-drying method, and stained in Hæmatoxylin–Eosin. Note the considerable thickness of the mesoglœa, which is probably the natural condition. (× 100)

When the specimen is dry, infiltration with wax is carried out *in situ*. The residual methyl chloride is pumped out of the cooling jacket and is replaced by commercial ethyl alcohol. An electric heating element (built into the cooling jacket) is switched on, and the pressure in the jacket is reduced by the jacket pump to allow the alcohol to boil at a suitable temperature for melting the wax without overheating. During infiltration, the pressure in the main vacuum line is allowed to rise to an appreciable fraction of the atmospheric pressure, since we have found that lower pressures rapidly volatilize the low-melting point fraction of the wax; if this occurs, its melting point may rise as much as 10–15° C., producing blocks which are brittle and impossible to section.

After embedding, the block is sectioned and the ribbon of sections is flattened on a clean mercury surface at 50° C., sufficient to soften the wax without melting it. (We are indebted to Prof. J. F. Danielli for this suggestion.) A suitable photographic emulsion (on glass) is momentarily pressed on to the floating section, which can be removed perfectly flat and dry.

So short a contact with mercury does not affect the photosensitive properties of the emulsion, which is then 'exposed' to the tracer action for any desired time. If a control section is used for histological comparison, the autoradiograph section is dissolved off with xylol, the plate is run through an aqueous alcohol series and, when in water, is developed and fixed. If it is desired to retain the exposed section intact, a light touch of 1 per cent celloidin in ether–alcohol, applied with a fine camel-hair brush to the dry section, will fix it in place during the subsequent processing.

By the use of electron-sensitive emulsions such as the Kodak *N.T.*4 or Ilford *G.5*, the sensitivity of the autoradiographic method can be increased about ten thousand times as compared with that using ordinary X-ray type emulsions (see also Boyd and Levi[3] for the use of this method with carbon-14). Sections giving a Geiger–Müller β-particle count of only 10 counts/min./sq. mm. of section give autoradiographs of excellent contrast with an exposure of a few hours, and by studying individual tracks instead of photographic density, the emission of as few as four β-tracks from a single *Colpidium* has been recorded with a three-hour exposure. A track radiograph of a more active sample is shown, in Fig. 1, and a section of *Hydra* frozen-dried by the method, in Fig. 2, to illustrate the satisfactory histological preservation achieved.

This work has been largely made possible by a generous grant from the Medical Research Council, and we also wish to thank Messrs. Kodak and Messrs. Ilford for the provision of special emulsions from time to time.

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J. F. SLOANE
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Department of Zoology, and
H. H. Wills Physical Laboratory,
University of Bristol. April 26.

[1] Winteringham, F. P. W., *et al.*, *Nature*, **165**, 149 (1950).

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Spectroscopy of Cells: the Use of a Reflecting Microscope and Spectrographic Recording

THIS communication describes the use of a simple microspectroscopic method which permits the recording of the ultra-violet and the visible absorption characteristics of cells or portions of cells within a period of a few seconds. The apparatus consists of a light source which emits radiation throughout the ultra-violet and the visible spectrum, a microscope with a reflecting achromatic condenser and objective of numerical aperture 0·56 (designed by Mr. A. J. Kavanagh and made by the Scientific Instrument Division of the American Optical Company), and a small quartz spectrograph (Hilger).

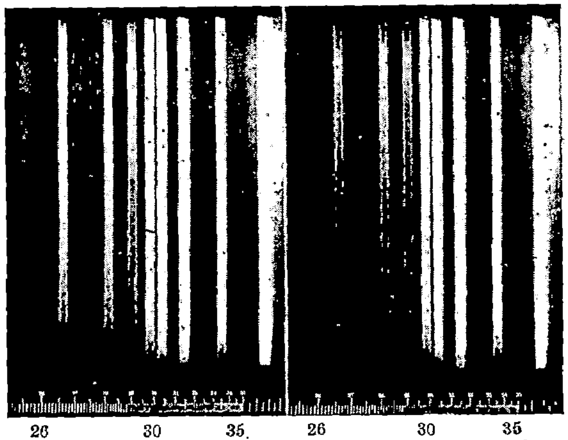


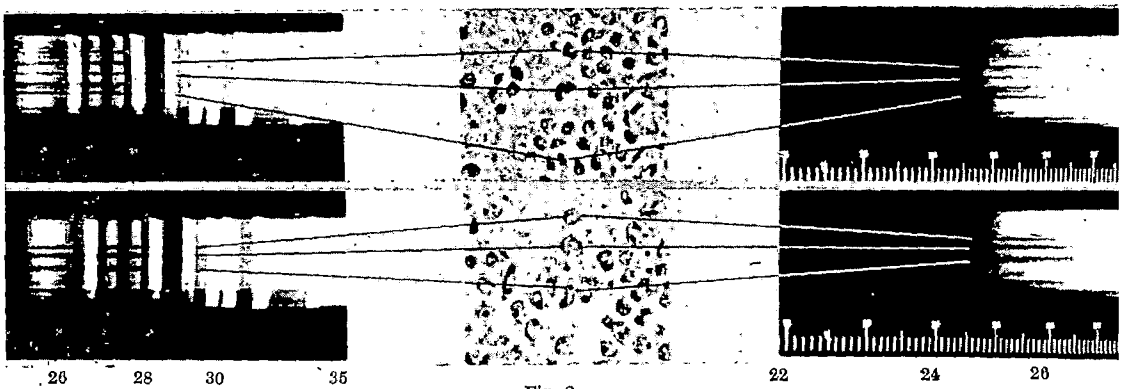
Fig. 1. Reference mercury spectrum (on left) and similar recording (on right) for living cell in tissue culture (chick embryo heart). Wave-length scale in 10 mμ

The principle of the method has been desc
by Barer[1] and by Barer, Cole and Thompsor
their use of the Burch[3] reflecting microscope.
achromatic reflecting condenser focuses the vi
and the ultra-violet spectrum of the source on
object. An achromatic reflecting objective form
image of the object on the slit of the spectrogr
These images are dispersed by the quartz spe
graph and refocused on the photographic plate
series of discrete or overlapping monochron
images, of which there exists one for each w
length of light emitted by the source. For
quantitative estimation of absorption in relatio
a reference spectrum and for the detection of
detail in the spectrum, the photographic plate
be moved during exposure by means of a logarit
cam in accordance with the method of Holida

The light sources that are used are the bright
spectrum of the mercury arc (type *AH*-4) in an il
inating system designed by the Research Departn
Polaroid Corporation, and the continuous spec
of the hydrogen arc. The image magnificatio
the slit of the spectrograph is 50 ×, while at
photographic plate it is 150 ×. The focus at
plane of the slit is made in visible light. The
formity of the illumination of the slit is detern
by densitometric study of the photographic im
The minimum width of the slit which can be
is 0·02 mm., which corresponds to a dimensio
0·4 μ in the object, while the maximum widt
0·3 mm., which corresponds to a dimension o
in the object.

The recording materials are chosen on the ba
various characteristics: Kodak *SWR* for the
ultra-violet region; Kodak 103–0 *UV* for sp
Kodak Metallographic for general use. The
required for exposure varies from a fraction
second to sixteen seconds, which is the time fo
excursion of the logarithmic cam.

Studies, which will be the subject of future rep
were made of a wide variety of cell-types util
various means for their preparation. It is of
ticular interest that the spectroscopic metho
applicable to living cells in tissue culture. In F
on the left is a reference mercury spectrum w
logarithmic exposure, while on the right is a si
recording for a portion of a living interphase c
tissue culture (chick embryo heart). The inju
effect of the ultra-violet radiation was not mar
during the few seconds required for recording
spectra, but became apparent about twenty mi



Cellular absorption spectrum (bright-line source)

Fig. 2

Above, smear of lymphocytes of mouse spleen; below, smear of leukæmia cells of mouse spleen. (Photomicrographs by phase microscope)

Cellular absorption spectrum (continuous source) the completion of the study. Comparable ies on living cells in mitosis indicate a shorter -lapse before an injurious effect is seen.

nears of exfoliated cells, such as those of diag- ic importance in clinical cancer, and smears of marrow are nearly ideal material. A series of -violet spectral images of immature leukæmia derived from human bone marrow have been sed in a microdensitometer after appropriate ration of the plate, and the characteristics of the ecorded in terms of its spectral absorption along plane perpendicular to the plate. When the ograph is astigmatic as in the present study, is distortion of the image for which allowance be made.

ears, or thinly spread preparations of soft , are suitable material. In Fig. 2 are represent- dies of two smears of mouse spleen, one ng normal lymphocytes and the other con- abnormal lymphocytes of leukæmia in the train of mouse (kindly supplied by Dr. J. H. nal). The absorption spectra, when recorded continuous source as shown on the right, oth in the horizontal, or *spectral*, dimension the vertical, or *morphological*, dimension.

sue sections in general are less satisfactory and nore difficult to prepare. It is necessary either eeze, cut[5], and dry[6] unfixed tissue in the frozen , or to use a material for embedding, such as ethylene glycol[7], which minimizes the loss of lar constituents in the histological solvents. Thin ns must be used in order to decrease the loss ight by dispersion. Ultra-thin sections[8] may e to be eminently satisfactory if an embedding dure can be devised which avoids the use of olvents.

ctrographic method described can also be tudy the primary fluorescence spectra of components of cells and the secondary nce spectra induced in cells by the localiza- fluorochromes. The visible light, or selected s of the ultra-violet region, emitted by the e is filtered out, and the fluorescence spectra are ded with a very sensitive panchromatic emulsion.

is work was aided by grants from the American Society and the National Cancer Institute of ited States Public Health Service, and one (R. C. M.) held a fellowship grant of the ican Cancer Society recommended by the Com- e on Growth of the National Research Council.

wish to thank Mr. A. J. Kavanagh, of the arch Laboratory, American Optical Company, ford, Connecticut, for the opportunity of using eflecting microscope lenses and for many helpful estions. Likewise we are indebted to Mr. Richard licky for the construction of the logarithmic cam anism.

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New York, N.Y. Dec. 8.

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49).

Helium II Transfer on Metal Surfaces

ONE of the most striking features of the film flow in liquid helium II is provided by the fact that the rate of transfer seems to be largely independent of the experimental conditions[1]. It was thought for some time that the rate was influenced by the geometrical shape of the transfer vessel, or by a temperature gradient in the film[2], or by small amounts of thermal radiation[3]. However, recent experiments by R. Bowers and one of us[4] have demonstrated that the real cause for these changes in the transfer-rate was a contamination of the solid surface over which the transfer took place with a thin layer of solid air. It was also found that contamination with solid hydrogen and solid neon produced similar effects.

These observations directed attention to the nature of the transfer surface and in particular to the influence of thin adsorbed layers of a second substance. Practically all quantitative observations of the transfer-rate have been made on glass surfaces. It was noted in the early experiments of Daunt and Mendelssohn[1] that scraped copper wires yielded a higher transfer-rate; but subsequent experiments with a polished copper beaker showed the same rate as on glass. Nevertheless, it has to be borne in mind that all these surfaces had been exposed to air and water vapour before examination, and this might have influenced their transport properties. In view of the recent results of Bowers and Mendelssohn, a re-examination of the problem with uncontaminated surfaces seemed, therefore, indicated.

The experiments were carried out in a small Linde helium liquefier[5], and provision was made for degassing the transfer surfaces thoroughly before the observation. The conventional type of beaker was used which, however, could be heated first *inside* the apparatus if necessary to about 600° C. After de-gassing, the solid surface was only exposed to the very pure helium gas employed in the liquefaction process. Platinum and nickel were used, the former because it was certain to be free from an oxide layer. Cylindrical metal beakers were suspended in a narrow vertical glass tube which was partly filled with liquid helium II, and the rate at which the liquid-level changed in the annular space between metal and glass was observed. The character of the film transfer was identical with the earlier observations, being in first approximation independent of the level difference and of the length of the path traversed. The dependence of the rate on temperature, too, was roughly similar to that on clean glass beakers; but the absolute value of the flow was considerably higher. On the other hand, a glass beaker used in the same arrangement yielded the same rates as all the earlier experiments. A short summary of the results is given in the accompanying table.

TRANSFER RATES OF HELIUM II OVER DIFFERENT SURFACES
(10^{-5} CM.^{3}/CM./SEC.)

a considerably higher rate has been observed on clean platinum and nickel than on clean glass, it is clearly too early to say whether this effect is due to the different type of interatomic forces or to more macroscopic features of the surfaces. A more detailed description of the work will be published in the near future.

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April 21.

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The D—D Reaction as a Standard Neutron Source

The first of the two possible D—D reactions

$$D_1^2 + D_1^2 \rightarrow He^3 + n$$
$$\rightarrow H^3 + H^1$$

has long been used as a source of mono-energetic neutrons. To use it as a standard source of neutrons requires either the counting of all the neutrons, using, for example, a water-tank method, or the counting of the helium-3 particles, which is difficult because of their very short range. But if, with given conditions, the ratio of the number of helium-3 particles to the number of hydrogen-3 or hydrogen-1 particles from the second reaction is once found, then the neutron flux may afterwards be determined merely by counting the number of hydrogen particles, which is much easier owing to their greater range.

Experiments were performed to find this ratio using a copper block as a target. The block was bombarded with a deuteron beam accelerated from a radio-frequency ion source using a voltage-multiplying circuit. With a 100-μ amp. beam, a counting-rate of 1,000 per minute was observed in a solid angle of $4\pi \times 10^{-4}$ radians from the deuterium driven into the target.

The counting of the helium-3 particles was made possible by the use of the thin silica windows of thickness equivalent to 0·2 mgm./cm.^{2} of air, described by Thonemann[1]. The charged particles emitted at 90° to the beam passed through this window into the first of two proportional counters. At a pressure of 11 cm. of mercury (10 : 1 argon – alcohol mixture) the helium-3, hydrogen-3 and hydrogen-1 nuclei gave pulses of relative magnitude 12 : 4 : 1 respectively. By using a pulse-amplitude selector, the helium-3 and hydrogen-3 peaks could be completely separated, and the incomplete separation of the hydrogen-3 and hydrogen-1 peaks would not introduce err

Energy in keV.	80	110	140	
Ratio H^3/H^1	1·01 ± 0·04	0·95 ± 0·06	1·01 ± 0·03	1·02

Three different sets of experiments using dif counters, and in one case an aluminium instea copper target, gave consistent results.

The ratios of the number of helium-3 partic the number of hydrogen-3 particles at dif incident beam energies were found to be:

Energy in keV.	70	80	90	100	11
He^3/H^3	0·86	0·89	0·906	0·92	0·9
Standard statistical error	±0·02	0·03	0·01	0·01	0·01

Energy in keV.	140	160
He^3/H^3	1·00	1·02
Standard statistical error	±0·01	0·03

As the distribution of deuterium in the ta not known, absolute cross-sections cannot be o using this type of target. Preliminary run gas target at 120–160 kV. do not show any s deviation from the above results.

We wish to express our thanks for the he by Dr. D. Roaf and the other members of t Tension Group.

K. G. McNe
P. C. Thone
F. V. Price

Clarendon Laboratory,
Oxford.
April 24.

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Mechanism of Ignition by Local Source Heat

The conditions under which combustible m may be ignited by contact with hot bodies, h the subject of intensive investigations, the object of determining the minimum te of the body necessary for ignition. Experim recently been reported by Jones[1] in which th necessary to ignite certain deflagrating so means of a hot wire embedded in them was mea the wire being heated by means of an electric cu maintained for a limited time. The experi showed that a definite amount of energ supplied to the wire for ignition to re quantity decreasing as the rate of supply i but still remaining finite even when the rate of is infinite, corresponding to the instantaneous g tion of heat in the wire.

The use of wires of different materials indi that under conditions where it was supplied stantaneously, the energy necessary for ignition sisted of two parts, one part being transferred to solid and the other part remaining in the wire. the range of diameters considered, 1×10^{-3} cm 5×10^{-3} cm., the energy transferred to the solid constant, but that remaining in the wire was portional to the thermal capacity and equiv herefore, to a constant temperature of wir The critical energy transferred to the s

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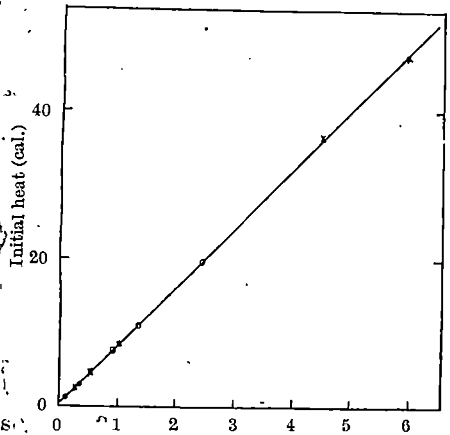

heat in sphere versus thermal capacity, from Silver's a 20 per cent hydrogen – air mixture ; × – × –, platinum spheres ; ⊙ – ⊙ –, quartz spheres

with loss of heat does not reduce the temperature
differ ire below a certain critical value.
and in riments carried out by Stout and Jones[2] have
Ti that similar conclusions may be drawn regard-
are the ignition of explosive gas mixtures by heated
to f, and that again, when heat is generated in the
stat instantaneously, ignition will occur provided a
pol in minimum quantity of heat is transferred to
cell gas, the temperature of the wire being greater
sect a certain critical value during the whole time
of ired for the transfer.
pro e above conclusions refer to cylindrical sources
proc t, and it is interesting to examine from this
lipid f view experiments carried out by Silver[3] and
The sp These authors projected heated spheres
used to s ive gas mixtures and measured the lowest
natural ire at which ignition occurred. Platinum
fluoresc tz spheres were used, of varying diameter,
tion of as found that for a given velocity of pro-
portion the smaller the diameter of the sphere the
sourc the temperature required for ignition. In the
reco of the experiments with the wires, it would be
Tl ted that the thermal capacity of the sphere is
Cancer ant factor, and the graph shows the initial
the Un tained in the spheres plotted against the
of us capacity, using Silver's data for 20 per cent
Ameri gen – air mixture. The heat in the sphere
mitt ses linearly with the thermal capacity, and the
We ep at zero thermal capacity is about 0·4 cal.
Rese slope of the line corresponds to a temperature
Star 92° C., which represents the temperature of the
the re when ignition occurs. Platinum and quartz
sugg ve similarly in spite of great differences in specific
Zab and density, and it will be found that equivalent
mec lts are obtained for the other gases studied by
r and Paterson.
e hot sphere shot into the gas is analogous to the
with heat generated instantaneously, and it is
Sloe that exactly the same conclusions apply. The
difference lies in the magnitude of the critical
[1] Bar ities, for whereas the graph shows that the heat
[2] Barer o the gas by the sphere is 0·4 cal. and the
(1 rature 792° C., the corresponding results for
[3] Burch n of a 20 per cent hydrogen – air mixture by a
[4] Holid are about 6 × 10⁻⁴ cal. per cm. and a tempera-
[5] Lind Ce f 2,000° C. Expressing the heat losses in relation
[6] Gersh area of hot surface, these become about 0·04
[7] Carst r sq. cm. for the wires and about 1 cal. per
[8] Pease m. for the spheres. The latter quantity will

depend to some extent on the velocity of the spheres in the gas[4]; but there seems no doubt that ignition may be effected either by a small quantity of heat supplied at a high temperature, or by a larger quantity of heat supplied at a lower temperature. The precise conditions will depend on the thermal capacity of the source, for that of the spheres averaged about 10^{-2} cal./° C. whereas that of the wires averaged only 10^{-6} cal./° C. The spheres could therefore withstand a much greater loss of heat than the wires without their temperature falling too low.

When heat is supplied to the source slowly, as with the wires, although similar conditions are necessary for ignition to occur, there is no reason for supposing that the temperature of the wire at ignition is the same irrespective of the rate of heating. The very fact that the energy required is greater the slower the rate of heating is sufficient indication that the temperature of the wire is reduced under these conditions.

It must be emphasized that the experiments discussed provide information solely concerning the division of the critical ignition energy between source and medium. Any conclusions drawn regarding the detailed thermal conditions existing in the medium at the moment of ignition must be regarded as purely conjectural.

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Low-Frequency Dielectric Absorption in Organic Long-Chain Compounds due to the Presence of Traces of Alcohol Impurities

IN recent investigations of the electrical properties of crystalline long-chain ketones and esters[1], considerable dielectric absorption has sometimes been observed at low audio-frequencies. This absorption appears to have electrical characteristics similar in all respects to the well-known low-frequency absorption which is usually attributed to ionic impurities or structural discontinuities, or a combination of the two (see, for example, ref. 2). The above measurements are now being extended to frequencies as low as 0·5 c./s., using a Schering bridge with a Lindemann electrometer as detector. The bridge is supplied with alternating potentials from a motor-driven sine-cosine potentiometer and 135-volt dry battery. Mercury electrodes with a clamped steel guard-ring are used, the electrode system being similar to, but smaller than, the one described by the Electrical Research Association[3]. Measurements of anomalous charging currents following the sudden application of a steady D.C. voltage are also being made, using the Lindemann electrometer in the way described by Doust and Sulston[4]. When possible, the steady-state D.C. conductivity (σdc) has also been obtained from the same readings.

In general, it is found that the dielectric loss factor continues to increase with decreasing frequency in this region. In the course of these experiments it was observed that the highest losses were associa with materials which had been purified by vac distillation. Subsequent recrystallization of such materials from a solvent led to a considerable reduction in the loss factor, accompanied by an even larger decrease in the D.C. conductivity. The following results were obtained, at about 15° C., with the long-chain ketone, palmitone:

	σ D.C. ($\times 10^{-15}$ mho-cm.$^{-1}$)	Dielectric loss factor at 3·9 c./s.	1·3 c./s.	0·44 c./s.
Vacuum-distilled	8	0·10	0·22	0·41
Recryst. from alcohol	0·1	0·002	0·004	0·005

Since the vacuum fractionation of these compounds involved heating at high temperatures in a restricted supply of oxygen, it seemed probable that the observed effect on the electrical properties was related to the presence of oxidation products in the material. In support of this, the ketone laurone gave the following results, before and after heating for two hours at 100° C., with restricted access to the atmosphere:

	σ D.C. ($\times 10^{-15}$ mho-cm.$^{-1}$)	Dielectric loss factor at 3·9 c./s.	1·3 c./s.	0·44 c./s.
Before heating	<0·05	0·002	0·002	0·003
After heating	1·5	0·068	0·12	0·21

Paraffin wax was more stable and required heating for two hours at 330° to give an increase similar to that shown above for laurone.

The autoxidation of long-chain compounds is known to proceed through the formation of hydroperoxides which are unstable and decompose to give alcohols, ketones, acids and aldehydes (see, for example, ref. 5). To determine whether any of these impurities are responsible for the dielectric absorption and high conductivity of oxidized long-chain compounds, electrical measurements were made with paraffin wax to which small proportions of compounds of the above-mentioned types had been added. The addition of 1 per cent of methyl hexyl ketone, *n*-heptaldehyde or caprylic acid gave comparatively little change; but a large effect was obtained with *n*-octyl alcohol ($C_8H_{18}O$), as shown by the following results:

Paraffin wax	σ D.C. ($\times 10^{-15}$ mho-cm.$^{-1}$)	Dielectric loss factor at 3·9 c./s.
1. Untreated	<0·004	0·000
2. + 1 per cent of *n*-octyl alcohol	4000	4·0

Large increases in D.C. conductivity and dielectric loss factor also resulted from 1 per cent additions of *n*-hexyl, *n*-heptyl and secondary octyl alcohols; but cetyl alcohol ($C_{16}H_{34}O$) produced only a small change.

It thus seems probable that the high dielectric absorption at low frequencies and high D.C. conductivity observed with oxidized long-chain compounds are due to the presence of small proportions of alcohols of comparatively short chain-length. The alcohol molecules may be adsorbed at crystal interfaces in such a manner as to enable the formation of hydrogen-bonded chains of hydroxyl groups, which have previously been suggested as a cause of high dielectric absorption in solid secondary alcohols at low frequencies[6].

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Fundamental Lengths and Masses of Fundamental Particles

CERTAIN considerations based on the principles of quantum mechanics lead to the view that the process of localization of a particle in space and time is subject to quantization. Thus if the world line of particle of rest mass m_0 is considered, it has no physical meaning to subdivide it into elements of length less than h/m_0c, or, what is the same thing, to associate with the particle intervals of proper time less than h/m_0c^2 [1]. This has been expressed as a principle of elementary indeterminacy by Ruark[2] and by Fürth[3].

In the case of the proton, of rest mass M_0, the length h/M_0c might be regarded as the fundamental length of the order of 10^{-13} cm., which has come to be described as the range of nuclear forces. In a recent paper, Fürth[4] has identified this length with Yukawa's expression $h/2\pi\mu_0c$ for this range, μ_0 denoting the mass of the π-meson associated with the nuclear field.

The range of nuclear forces might also be identified with the expression ke^2/m_0c^2, where m_0 is the rest mass of the electron. Unlike the other expressions, this contains a numerical constant k which is not well defined theoretically. Such values as $\frac{1}{2}$ and $\frac{2}{3}$ have been ascribed to it in the classical theory of the electron, and Fürth[5] by a rather different consideration deduced the value 15/32. The constant is evidently of fundamental importance, and if ke^2/m_0c^2 is regarded as a fundamental unit of length, it ought to be derived without any considerations of electron structure or charge distribution. The identification with the other expressions for the range of nuclear forces makes it possible to deduce the value of k_0 with a high degree of accuracy.

Thus, making use of recent data[6], $2\pi e^2/hc = 7{\cdot}2978 \times 10^{-3}$, $M_0/m_0 = 1836{\cdot}57$ (with a certain margin of error), the relation $h/M_0c = ke^2/m_0c^2$ gives $k = 0{\cdot}4688$. Fürth's value, namely, $15/32 = 0{\cdot}46875$, is in remarkable agreement with this.

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agnetism and the Rotation of Celestial Bodies

cent letter, H. P. Berlage[1] has ingeniously
d to use the idea of a radial separation of
charge, associated with degenerate matter
terior of rotating celestial bodies, in order
Blackett's formula[2], which seeks to connect
ular momentum of such a body with its
moment.

an show that, in order to account for the
agnetic field of the *earth*, Berlage's model
that some 10^6 or more electrons/cm.^{3}, from
eciable part of the earth's core, would need
gy of the order of 10^{17} volts, in order to pro-
e necessary migration and separation of
as a result, there would have to exist an
field of 10^9 or more volts/cm. at the boundary
core.

the earth's core is rather widely thought to
llic, for one reason or another, it is appropriate
nine the possibility that an appreciable sep-
of electric charge may occur in a conductor
ed to the high pressure and temperature of the
deep interior.

sure acting alone could cause a charge separa-
the proper sign; but, as has recently been
l out[3], the effect to be expected is very small.
rature, acting with pressure, does not seem
appreciably, as can be seen by considering
ermi–Dirac distribution of the conducting
ns in a compressed conductor at high tempera-
The number of electrons per cm.^{3} per unit of
may be written

$$\rho_E = \frac{\nu\sqrt{E}}{1 + \exp\left(\frac{E - E_m}{kT}\right)},$$

E is the energy of the conducting electrons,
$\frac{\pi}{\;^3}(2m)^{3/2}$ and, closely enough, $E_m = \frac{h^2}{2m}\left(\frac{3n}{8\pi}\right)^{2/3}$,
ich h is Planck's constant, m is the effective
of the electron, T is the absolute temperature,
Boltzmann's constant and n is the number of
cting electrons per cubic centimetre. E_m is the
num energy of the conducting electrons at 0° K.

st consider the effect of compression alone.
g convenient round numbers, assume E_m to be
lts before compression, and that the pressure
n the earth increases the density there by a
of 8. (This is an assumption favourable to the
y; actually, it is unlikely that so large a com-
ion could occur.) If m and n remain constant
g compression, the maximum energy of the
rons after compression, E_m', is 40 volts. We
probably not justified in treating m and n as
tants during so great a compression; but this
nption cannot introduce an error large enough
lter the conclusions that follow below.

condly, let us take into account the effect of
perature, assuming T to be 10,000° K. (The
perature deep inside the earth is quite uncertain,
a rough value will do for these calculations;
00° K. is not unreasonable.) On carrying this
we find that ρ_E is a maximum when E is about
electron volts. Owing to the relatively small
ct of temperature, ρ_E decreases rapidly with
easing E. As a result, we find, for example, that
$E = 85$ volts, ρ_E is about 1 electron per cm.^{3} per
tron volt. In other words, there is only about one electron per cubic centimetre having an energy as high as 85 volts, where we should like to find some 10^6 or more electrons having energies of the order of 10^{17} volts.

Thus, for an earth with a conducting core, the difference between the predictions based on the Fermi–Dirac statistics, and the requirements of the charge-separation theory, are so great that it is hard to see how terrestrial magnetism can be due to any appreciable extent to this effect.

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Origin of Sunspots

ALTHOUGH astronomers have commonly believed that sunspots are deep-seated vortices, the chief characteristics of a spot (an intense magnetic field and a cool umbra) have never been successfully explained.

I wish to suggest a new theory of spot origin. One basic assumption is that the sun possesses a general magnetic field, the polar intensity of which is probably only several gauss, from ten or twenty times less than the value usually quoted. The form of the solar corona, which strongly suggests the lines of force emanating from a magnetized sphere, justifies the assumption.

If an ionized and highly conducting gas moves with velocity v in the presence of a magnetic field H, an electric field E results:

$$E = \frac{1}{c}\, v \times H. \qquad (1)$$

Taking the curl of this equation, and employing the Maxwell equations, we find that

$$\frac{dH}{dt} = H \cdot \nabla v - H\nabla \cdot v. \qquad (2)$$

Introducing the equation of continuity, we finally get:

$$\frac{d}{dt}\frac{H}{\rho} = \frac{H}{\rho} \cdot \nabla v, \qquad (3)$$

where ρ is the matter density of the ionized gas. Equations (2) and (3) show that the lines of force move with the material and that changes of gas intensity generally imply changes in intensity of magnetic field.

Clouds of ionized gas, ejected from the solar poles in 'spicule activity', can cascade back to the solar surface near the equator. The influx of gases can produce, in accord with (3), a marked intensification of the magnetic field.

An examination of generalized hydrodynamic equations shows that the ionized gas will collapse when the gravitational acceleration exceeds the buoyancy effect of the magnetic field. The general characteristics of many varieties of prominences can thus be explained. Sunspots may result from complete collapse of the field down to the solar surface. The downfalling material will generally flow out away from the magnetic cores and thus produce cooling. The details of this theory will be given in a later paper.

I wish to acknowledge the help, advice and encouragement given to me by various colleagues, in particular Walter O. Roberts, John W. Evans, Edward Teller, Julian Schwinger, J. H. Van Vleck and M. S. Vallarta.

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Biological Assay of Small Quantities of Desoxycorticosterone Acetate

ALTHOUGH early studies on the adrenalectomized dog[1] have led to means of assay for desoxycorticosterone acetate and for extracts of the adrenal cortex in quantity[2-4], no satisfactory micro-assay has hitherto been described.

In the course of other experiments, methods were developed whereby accurately measured volumes of fluid could be administered to small animals[5]. This technique has been used to give precise salt and water loads to large adrenalectomized mice, with and without injections of desoxycorticosterone acetate. The subsequent rates of sodium excretion have been shown to be related quantitatively to the amounts of desoxycorticosterone acetate injected, over the narrow range of 1·5–12 micrograms per 100 gm. body-weight.

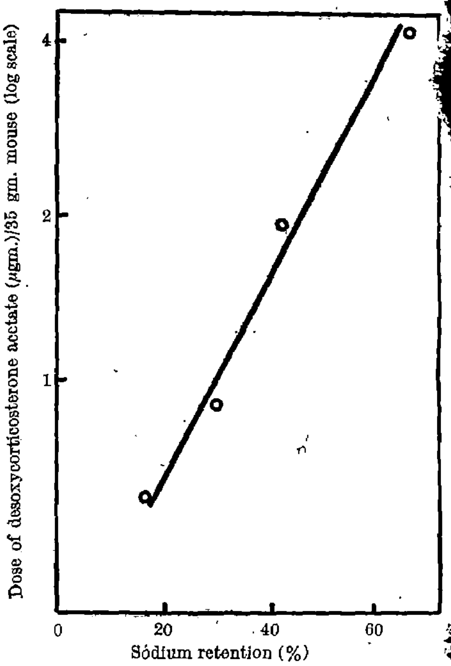
Male Swiss mice weighing 35 gm. were bilaterally adrenalectomized and used for testing from the fourth to the seventh post-operative days. They were fed a standard Rockland mouse diet, with 1 per cent sodium chloride and 5 per cent glucose to drink. To avoid fæcal contamination of urine during test periods, the mice were kept fasting for eight hours before each assay. During this time, 10 per cent glucose water, without salt, replaced the glucose-saline drink. This was to prevent hypoglycæmic attacks, which were otherwise common in fasting adrenalectomized mice, and to ensure that all the animals had no sodium intake before the assay.

Preliminary tests on groups of eighteen mice allowed twelve to be selected which would excrete 70–130 per cent of the sodium load within a period of six hours. At the beginning of the test, the mice were picked up and the bladders were emptied either spontaneously, or by gentle suprapubic pressure. Each mouse was then in turn injected subcutaneously with 2 ml. of the load solution, warmed to 40° C. This solution contained: sodium 138, potassium 4, calcium 3 m.equiv./litre, chloride 128, phosphate 11, bicarbonate 6 m.equiv./litre, and glucose 1 per cent.

The injection apparatus was an all-glass 10-ml. syringe, with a $1\frac{1}{2}$-in. No. 26 S.W.G. needle, fixed horizontally in a clamp, and with delivery controlled and measured by a micrometer screw gauge acting on the piston. Each mouse, held gently in a gauze bag, was brought up to the apparatus and the needle inserted near the tail and carefully slid under the skin to the neck. The injection of 2 ml. was then slowly and evenly distributed around the shoulders. In this manner all the fluid was injected at low tension and distant from the needle puncture, so that none leaked out afterwards.

After injection, each mouse was placed in a one-litre beaker, with wide-gauge wire-mesh platform and lid, and kept in the laboratory at 25 ± 3° C. Six hours later the mice were removed, after emptying their bladders into the beakers. These rinsed four times with 20 ml. of distilled the washings made to volume for the esti sodium by indirect flame photometry[6].

On the next day, the twelve selected r pared and injected as before, were divided i groups. The first were injected intraperi with a control solution of 0·2 ml. of 5 per cent the second with the same solution containi μgm. of desoxycorticosterone acetate, and th containing the substance to be tested for r hormone activity. After six hours the excre sodium was measured as previously describe each subsequent day the groups of mice were c and the assay repeated until all the mice ha acted as control, standard and unknown tes This cross-over test minimizes errors due to indiv response variation, and to any influence of on phase on the next.



The means of the differences of the percen sodium retention were taken as a measure of des corticosterone acetate activity. Analysis tests on 73 mice shows that, with selected grou twelve mice, a mean difference of sodium rete of 15 per cent is significant at a level of proba of $P = 0{\cdot}02$. The relation between log dos desoxycorticosterone acetate and the perce sodium retention is shown in the accompa graph. The standard error of the ratio of the p cies[7] may be calculated from the slopes of regre lines[8] for both standards and unknowns.

Blood sample	Sodium retention activity expressed as desoxycortico sterone acetate equivalent
Adrenal vein blood (dog)	4 μgm. desoxycorticosteron acetate per ml. serum
Carotid artery blood (dog)	No activity detected
Human blood obtained by catheter from inferior vena cava at level of 12th thoracic vertebra	No activity detected
Extract from 120 ml. serum from carotid artery blood of the dog	0·04 μgm. desoxycorticosterone per ml. serum

ethod of assay has been applied to blood
ous sources, with the results shown in the

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Oxidation of Glucose-6-Phosphate by Animal Tissues

subjec
meth
curre
tion ast[1–4] and red blood cells[5] contain enzyme
poin s which require coenzyme II and are capable
Ter oxidizing glucose-6-phosphate to 6-phospho-
to onic acid. The oxidation can also proceed
th her[1,3,6], and evidence has been presented that
ele east stepwise C_1- and C_2-oxidation and decarboxyl-
tur n may proceed via a pentose phosphoric ester;
en was considered to be D-ribose-5-phosphate
r than D-arabinose-5-phosphate, which, although
as the configuration of D-glucose, is not attacked
yeast enzymes[6]. Further support for this view
recently been provided by the chromatographic
tification of 2-ketogluconate and D-ribose-5-
w sphate among the oxidation products of
psphogluconic acid[7].
ese oxidative paths in animal tissues have not
in erto received detailed study[3,6,8]; but the pre-
m nary experiments now reported show clearly
k imilar enzyme systems are, in fact, highly active,
con ntly so to make it possible that they may
maxi ite a main route of carbohydrate oxidation,
F ne animal tissues.
Tak tissues were homogenized in 0·01 *M* phosphate
10 7·0 and the inactive precipitates formed by
deep the supernatant fluid to *p*H 4·6 and 7·0
facto d. Dehydrogenase activity was tested by
theo te of reduction of Brilliant Cresyl Blue using
pres mann and Hollander's method[9], and in the
durir d fractions described below by the method of
elect ; oxygen uptake was studied as described by
are s[6]. Active coenzyme II – linked systems for
cons idation of glucose-6-phosphate and 6-phospho-
assu ic acid are present in extracts of liver, brain
to a idney of rat and rabbit and in liver-carcinoma
S rat. These activities are not due to adventitious
ter . Extracts of rat and rabbit skeletal muscle
ten fowl sarcoma No. 1 show relatively feeble
bu ity.
10 fractional precipitation of rat liver extracts
o ammonium sulphate and subsequent dialysis,
3 ial separation of coenzyme-free dehydrogenases
e been effected. The crude fraction, between 30 and
i per cent saturation with ammonium sulphate,
ntains glucose dehydrogenase[11] and the dehydro-
nases for glucose-6-phosphate and 6-phosphogluconic acid. The percentage-saturations for maximum activity of these three dehydrogenases are, respectively, 30–40, 40–50 and 50–60. The last fraction is completely free from glucose-6-phosphate dehydrogenase, showing that these two phosphorylated substrates require distinct dehydrogenases. Oxidation of both glucose-6-phosphate and 6-phosphogluconic acid is specific for coenzyme II and occurs aerobically in presence of a suitable carrier, such as phenazine methosulphate[6], without added flavoprotein. Since glucose dehydrogenase requires coenzyme I and added diaphorase, it could not account for the activity towards glucose-6-phosphate. Moreover, no glucose-6-phosphatase is present in these fractions.

The substrate specificity is high. In the presence of coenzyme II, the 50–60 per cent saturation fraction, though highly active towards 6-phosphogluconic acid, does not oxidize Embden ester, glucose 6-phosphate, gluconic acid, 2-ketogluconic acid, glucose or ribose. The whole system (fraction between 30–60 per cent saturation) vigorously oxidizes glucose-6-phosphate, 6-phosphogluconic acid and D-ribose-5-phosphate (natural or synthetic). It shows slight activity towards D-arabinose-5-phosphate and xylose-5-phosphate, and also towards glycogen and glucose-1-phosphate, the crude system presumably containing some phosphorylase and phosphoglucomutase. Gluconic and 2-ketogluconic acids and ribose are scarcely oxidized.

The Michaelis constants for the glucose-6-phosphate and 6-phosphogluconic acid dehydrogenases are $5 \times 10^{-5}\,M$ and $1{\cdot}7 \times 10^{-5}\,M$, respectively. The oxygen taken up by 6-phosphogluconic acid and D-ribose-5-phosphate exceeds the molar ratio of unity corresponding to the formation of ketopentonic acid. The facts that neither the oxidation of glucose-6-phosphate nor that of 6-phosphogluconic acid is inhibited by 0·01 *M* sodium fluoride, and that inorganic phosphate is not essential, show that the Embden–Meyerhof glycolytic pathway is not involved.

The relative importance of this direct oxidative pathway and of the conventionally accepted route via the glycolytic intermediates is being investigated in adult and proliferating animal tissues. The direct oxidative route may have a dual function, in carbohydrate oxidation and in the provision of ribose-5-phosphate for synthesis of nucleotides and nucleic acids.

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Birefringence of Amylose and Amylopectin in Whole Structural Starches

THE view is current that unbranched amylose chains are responsible for the anisotropy of structural and fractionated starches[1-3]. (A review of this subject by S. Peat[4] should be consulted.) This view has been influenced by the method of investigation employed. Thus the evidence from X-ray powder diagrams does not entirely coincide with that from the study of optical birefringence. Perfectly dry starches are stated[5,6] to show an amorphous powder diagram though they still exhibit birefringence. The kind of product also matters. Thus, fractionated amylose may be deposited in a micro-crystalline form[4], whereas amylopectin remains amorphous or statistically isotropic. But fractionation procedures may also determine physical states, so that no direct conclusion can be drawn concerning the anisotropy of amylopectin in raw structural starches. Thirdly, interpretation may also be prejudiced by theoretical assumptions regarding the structure of the branched high polymer. Thus the random branching postulated by Meyer[1] would offer a resistance to crystallization absent from the models proposed by Staudinger[7] or Haworth[8].

We now report further evidence relating to these problems. Wrinkled pea, smooth pea, normal maize, waxy maize, and tobacco leaf starches were examined in polarized light. Wrinkled pea starch contains 98 per cent amylose and 2 per cent amylopectin[9]; smooth pea contains amylose and amylopectin in the ratio of 30 per cent to 66 per cent[9]; waxy maize contains amylopectin but no amylose[10]; normal maize contains amylose and amylopectin in the ratio of 21 per cent to 79 per cent[10]. Current investigations at the University College of North Wales, Bangor, show that the ratio of amylose and amylopectin in tobacco leaf starch is approximately 22 per cent to 78 per cent. Our sample of waxy maize starch was obtained from a strain of known genetic purity. We found that the birefringence of waxy maize was not distinguishable in intensity from that of normal maize; that the birefringence of the majority of the aggregate granules of wrinkled pea was conspicuously less than that of the semi-aggregate granules of smooth pea, although wrinkled pea starch always contained, as well as aggregate granules, a smaller number of semi-aggregate granules showing intense birefringence; and, in agreement with Holden and Tracey[11], that leaf starch possessed only minimal though definite birefringence.

These results show, first, that amylopectin in the raw starch granule possesses a crystallite structure, and that the intensity of birefringence bears no obvious relation to the amylose – amylopectin ratio of the granule. It is more plausible, therefore, to attribute the observed variations in birefringence to differences in degree of crystallite orientation rather than to differences in the degree of branching and relative proportions of their component polysaccharides. It was noteworthy that photosynthesized starch, which is deposited and mobilized with exceptional rapidity and in which, therefore, sufficient time may be lacking for full crystallite orientation, showed the least birefringence of the starches examined. The low birefringence of wrinkled pea starch may be due to a similar cause, since Winton[12] states: "The character of the starch grains in immature smooth peas is much like that in mature wrinkled peas. This suggests that the wrinkled pea, although fertile, is either gathered when immature or is incapable of reaching the same degree of development as the smooth variety." Moreover, rapidity of mobilization rather than degree of branching may be responsible for the absence of birefringence from the glycogen in mammalian tissues. In this connexion the little-studied polysaccharide complexes of the Protozoa deserve further investigation. For example, in the oligotrich ciliates of the rumen, iodine-reacting substances are deposited both in an amorphous form and as birefringent structures[13], the so-called skeletal plates. Westphal[14] claimed that both components are glycogen. If this were substantiated, it would show that glycogen as well as amylopectin can exist in a crystalline state.

We wish to acknowledge our indebtedness to Mr. N. W. Pirie, of Rothamsted Experimental Station, for supplying us with leaf starch and for advice on several technical points.

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[1] Meyer, K. H., and Bernfeld, P., *Helv. Chim. Acta*, **23**, 890 (1940).
[2] Samec, M., *Koll. Beih.*, **54** (vi), 147 (1943).
[3] Jaloveczky, P., *Bot. Kozlen* (*Ungarn*), **39**, 601 (1942).
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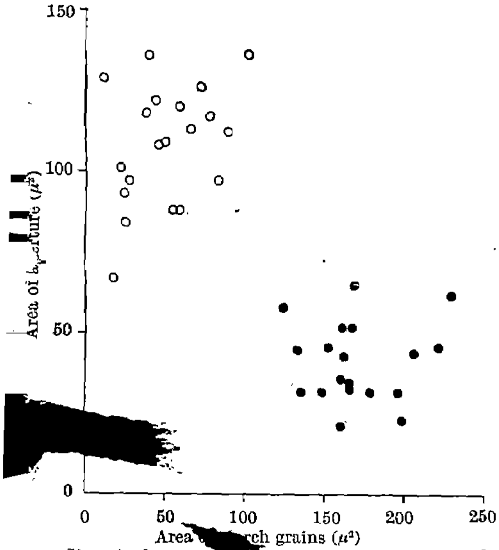
[14] Westphal, H., *Z. Parasitenk.*, **7**, 71 (1934).

Quantitative Estimation of Stomatal Starch

THE investigations of Heath[1,2] have shown that the classical theory of the control of stomatal movement by starch–sugar balance in the guard-cells must be viewed with the deepest suspicion, at least so far as the light response is concerned; but the difficulty in all such investigations has been the great variation in starch content between different stomata on the same leaf, and the absence of any satisfactory method whereby it could be measured. Neither the method adopted by Heath[2] (the publication of selected photographic records) nor the subjective visual 'scoring' method of Small[3] affords more than a rough survey of a large number of stomata; what is required is a method of estimation of the starch in individual guard-cells.

We have devised such a method, using as our measure the *area* of the starch-grains. Strips of epidermis were mounted in Heath's[1] reagent (which stains the starch without affecting the aperture), and stomata selected at random were photographed on 35-mm. film (Kodak 'Microfile'). The resulting negatives were projected from a Leica enlarger to give an overall magnification of 2,500 linear dimensions; the outlines of the starch-grains and the aperture were traced in pencil, and the areas measured with a planimeter. The starch grains do not lie accurately



—, Stomata from enclosed area ; ● — ● —, stomata from unenclosed area

plane, and almost invariably some are slightly
focus ; this difficulty could be eliminated by
projection of the original slide on to a screen
acing, re-focusing as necessary. However, the
ary equipment has not been available, and the
graphic method has therefore been adopted for
inary experiments. The use of a photometric
d for measuring the areas has been fully con-
d, but, for reasons which cannot be detailed
rejected.

have carried out two simple experiments which
nstrate the striking results that the technique
s. In the first, part of an illuminated *Pelar-*
m leaf was enclosed between two glass plates ;
already known[4,5,6] that the resulting drop in
n dioxide concentration causes wide stomatal
ng between the plates. A strip of lower epi-
s was taken from both enclosed and unenclosed
of the leaf by Lloyd's[7] method, the strips were
ferred to Heath's reagent, and the starch and
re measured in twenty stomata from each strip.
esults are shown in the accompanying scatter-
am. It will be immediately clear that, within
ne treatment, there is no sign whatever of
igh negative correlation that classical theory
lead us to expect ; but that enclosure has
icantly increased aperture and reduced starch.
still be argued that starch–sugar balance,
not responsible for variations in aperture
en individual stomata under substantially con-
conditions, yet controls major changes in
ure. However, Heath[2], referring particularly
work of Iljin[8], has pointed out that enclosure
increases the humidity of the air so enclosed,
has implied that there may be two effects—
tion of carbon dioxide acting upon aperture,
ase of humidity acting upon starch—which have
confounded. Despite the intractability of
gonium in February, we have attempted to
tigate this by enclosing part of a leaf between
s incorporating a drying-agent (calcium chlor-
Visual inspection discloses immediately that
enclosure does not cause any appreciable dim-
n in starch-content ; in fact, our computations
st that there has been a statistically significant
se in both aperture and starch. However, since we are as yet ignorant of the extent to which these quantities vary over the surface of any one leaf, we place no reliance on this result ; but it at least seems clear that the technique here outlined will enable us to undertake a fully quantitative investigation of this and related phenomena.

We are indebted to Dr. O. V. S. Heath for the loan of apparatus and to Mr. G. L. Robbins of Kodak, Ltd., for technical advice. A full discussion of the technique and a detailed account of the preliminary experiments will be published elsewhere in due course.

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High Light Intensities for Experiments in Crop Physiology

ATTENTION has recently been devoted in this Department to the development of a growth cabinet in which the environment can be controlled, eventually for use in pasture research in New Zealand. For this purpose the critical requirement is high light intensity with the quality of daylight, over an area large enough for adequate replication of the experimental plants. It is the experience of plant physiologists that it is difficult to obtain such lighting without the complications caused by excessive radiation. The following note may therefore be of interest.

The growth cabinet used can be run at any temperature from 40° F. to 75° F. ± 2° F., by circulating air past a heater and a thermostatically controlled cooler. There is no water screen between the lights and the plants. The evenly illuminated area is 5 sq. ft. ; it receives light from twelve 150-watt tungsten filament reflector spotlamps and twelve experimental 30-watt, 3-ft., blue fluorescent tubes. These lamps provide a continuous spectrum which, compared with sunlight, is slightly weaker in green and stronger in blue and red. The present maximum intensity at the level of the plants, 18 in. from the lamps, is equivalent to sunlight at 2,000 foot-candles. Below each tungsten bulb is a disk of Chance's '*O.N.*20' heat-absorbing glass 6 in. in diameter. Even when more than two kilowatts are being put into the lamp circuit, it has been necessary to switch on an 80-watt heater to maintain cabinet temperature at 70° F.

Experiments are being carried out on strains of *Lolium* under this light intensity. The evidence to date does not suggest that 2,000 foot-candles is the maximum to which *Lolium* will respond, and arrangements are being made to increase the light intensity still further.

In the design of the lighting arrangements particular thanks are due to Dr. J. N. Aldington, of Siemens, Ltd.

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Occurrences in Normal Human Sera of 'Incomplete' Forms of 'Cold' Auto-Antibodies

THE existence of 'incomplete' forms of antibodies active against human erythrocytes and detectable by means of the Coombs test[1] is now widely recognized. *Rh* antibodies are commonly present in this form, and so are some at least of the recently recognized rarer immune antibodies[2], such as anti-*Kell* and anti-*S*. The fact that the iso-antibodies anti-*A* and anti-*B* may similarly exist in incomplete forms is also being increasingly realized[3].

The possibility that 'cold' auto-antibodies might also exist in incomplete forms seems, however, scarcely to have been considered. Although Levine and Wigod[4] mentioned that 'cold' agglutinins might be a cause of confusion in carrying out the Coombs 'developing' test, they gave no details of the phenomenon. The purpose of the present note is to record that incomplete 'cold' antibodies active against corpuscles of all groups do, in fact, exist, and that they may be found in most, if not in all, sera from apparently healthy persons, as may 'cold' panhæmagglutinins at low titres.

The presence of these normally occurring incomplete 'cold' antibodies can often be demonstrated if defibrinated blood is chilled at 2–5° C. for 1–2 hr., and the corpuscles then exposed to the action of anti-globulin rabbit serum, after repeatedly washing them in saline warmed to 37° C. In these circumstances, although the 'cold' hæmagglutinins are rapidly eluted into the warm saline, the incomplete antibodies appear to remain adsorbed on to the corpuscles. A stronger reaction can be obtained if a weak (0·5–5 per cent) suspension of corpuscles is made in their own serum and dealt with as described above. Sometimes with weak suspensions a positive Coombs test will be obtained in this way, even if the sensitization is carried out at room temperature.

There is evidence that the presence of fresh serum is necessary for the adsorption of the antibody, for corpuscles suspended in serum previously heated to 56° C. for 5–30 min. fail to give a positive reaction after chilling. The addition of a small amount of absorbed fresh serum to heat-inactivated serum restores in part, however, its power of sensitizing corpuscles. Heparin (0·5 mgm. per ml.), sodium citrate (6 mgm. per ml.) or Wintrobe's oxalate mixture (2 mgm. per ml.) added to serum also inhibit sensitization to a greater or less extent, depending upon the titre of the antibodies and the potency of the anti-globulin rabbit serum. Another pointer to qualitative differences between incomplete 'cold' antibodies and incomplete anti-*Rh* is that anti-globulin rabbit sera are not necessarily equally effective in revealing sensitization by the two kinds of antibodies. Some sera, for example, although highly potent in revealing sensitization by anti-*D*, give weaker reactions with corpuscles sensitized by incomplete 'cold' antibodies, and *vice versa.*

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March 2.

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Heteropycnosis in Human Chromoso

INVESTIGATORS of human chromosomes n many years ago the presence of two chro masses or chromocentres in resting nuclei. C other hand, Schultz[1] was able to analyse in human material the structure of a couple of ele pairing at pachytene during spermatogenesis, spatially connected with a nucleolus, and, ther called nucleolus organisers.

The question arises whether there is a relati between nucleolus-organising chromosomes se the spermatocytes, and the two chromoce appearing in resting nuclei of different tis Suitable material is provided by the epithelia flaking off from the vaginal mucosa. Collectin vaginal fluid at the vaginal ostium, the cel numerous and in a living condit [illegible] showing mitotic stages. The us [illegible] with Acetocarmine staining is s [illegible] to giv preparations. Nearly four hundred nuclei have analysed, from eight women.

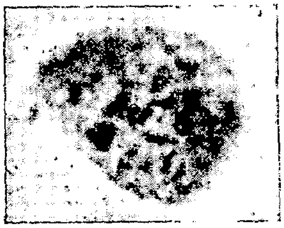

Fig. 1

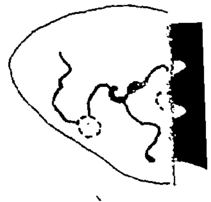

Fig. 1a

Fig. 1. Nucleus with two nucleoli. The nucleolus-organ chromosomes are very thin

Fig. 1a. Drawing of the nucleus in Fig. 1, showing nucleo nucleolar chromosomes only

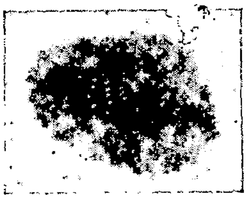

Fig. 2

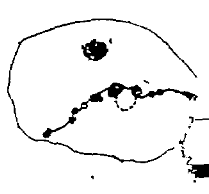

Fig. 2a

Fig. 2. Nucleus with one chromocentre, and one nu chromosome clearly stained

Fig. 2a. Drawing of the nucleus in Fig. 2

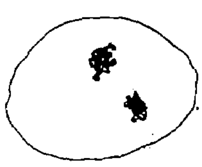

Fig. 3. Nucleus with two chromocentres. Nucleoli not vi (Magnification nearly 1,000 ×)

Such cells have nuclei showing all stages, from nucleolus-organising chromosomes with the structure as that described by Schultz to chromocentres: these two extreme cases are nected with a continuous chain of interme stages, where one of the chromosomes is contr (chromocentre) and the other appears in threa form (see Figs. 2 and 2*a*). This provides ev that the nucleolus-organisers are present also ving the same structure as is described by nd, therefore, must be considered as auto- Secondly, it seems that each nucleolus- is capable of forming one chromocentre. rizing, it can be said that in the forty-eight nes of man, there are two which are char- by a varying degree of heteropycnosis, at t degree of which they are often scarcely hable from the remainder of the chromatin. termination of the origin and number of ocentres in normal nuclei is of interest in with the problem of detecting proliferating t cells, where the chromocentres are ab- numerous[3].

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21.

., *J. Heredity*, 40, 31 (1949).
and Cusmano (unpublished data).
., *Nature*, 151, 244 (of sta

ous Results of Moth-Proofing Tests

course of testing the efficiency of moth- gents, anomalous results were obtained well-known compounds which had been conjunction with a neutral levelling acid ne Fast Blue). Further work on the prob- ikely in this laboratory so these results are here.

o moth-proofing agents were: (*A*) a sub- urea derivative, and (*B*) a sulphonic acid of triphenyl methane. Shrink-controlled woollens were moth-proofed at a woollen the following method. The dye-bath was to an initial *p*H of abc 3 with ammonia. edients were added and he bath heated to n 15 min. This temperature was maintained rther 15 min., when the *p*H was adjusted to cetic acid. The woollens were then removed d twice.

oofing efficiency was determined by loss f fabric tests[1] with the larvæ of two species moth (*Tinœa pellionella* L. and *Tineola* Hum.). Further determinations of effi- re made after two, four and six washings nestic type using a commercial soap powder. Chemical analysis showed a loss of the moth-proofing agent with washing (Fig. 1); but despite this there was a steady increase in moth-proofing efficiency after each washing (Fig. 2). This increase in efficiency was shown in separate series of tests with both species of moths for both (*A*) and (*B*).

Further tests carried out with agent (*A*) applied at 60° C. in an acid bath without dye on the same shrink-controlled fabric gave a usual curve of efficiency with both species of test insects, the efficiency decreasing with decrease of moth-proofing agent after washing (Fig. 3).

Where the moth-proofing agents were applied in the dye-bath under the first set of conditions, there was an apparent inhibition of moth-proofing efficiency which was progressively removed by washing. Thus, though chemical analysis might show a concentration of agent which was theoretically adequate for protection, in practice the efficiency of the agent might be too low to prevent damage. We would be interested to learn whether other workers have encountered this same anomaly and if any explanation is forthcoming.

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Reciprocal Translocations in *Pisum*

Some years ago I published an analysis of structurally changed types of *Pisum sativum* based on cytological observations[1]. One of these, structural type four which had arisen in the variety Extra Rapid, was reported as having chromosomes 3 and 5 interchanged, according to my notation. Recently, Lamm[2] and Nilsson[3] have challenged this statement, and on the basis of their genetical evidence claim that the *K* line (chromosomes 1 and 2 interchanged) and the Extra Rapid translocation have the chromosome carrying the *GP* factor, chromosome 2 on my notation, in common, and predict that the cross Extra Rapid × *K* should have an association of six chromosomes.

My records showed that this cross had two associations of four chromosomes, indicating that two separate chromosomes are involved in the two interchanges. This I have confirmed by a re-examination

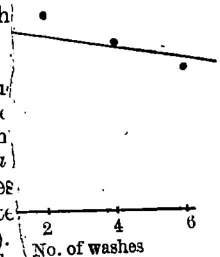

Fig. 1

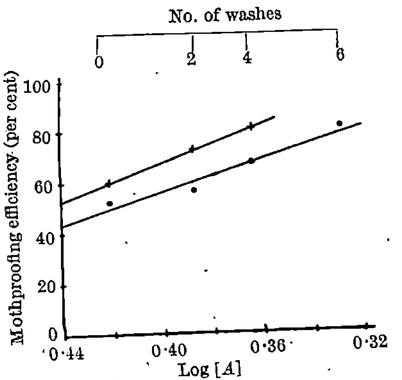

Fig. 2

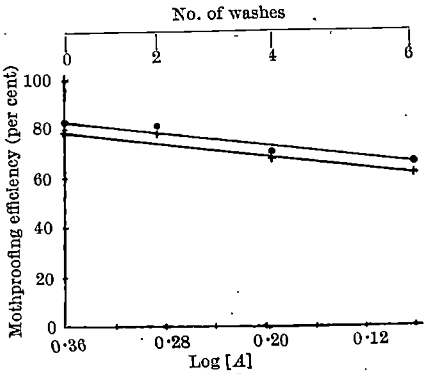

Fig. 3

Removal of '*A*' by washing. Fig. 2. Efficiency of '*A*' applied with dye at 100° C.: ●–●–, *Tinœa pellionella* L.; +, *Tineola bisselliella* Hum. Fig. 3. Efficiency of '*A*' applied without dye at 60° C.: ●–●–, *Tinœa pellionella* L.; +–+–, *Tineola bisselliella* Hum.

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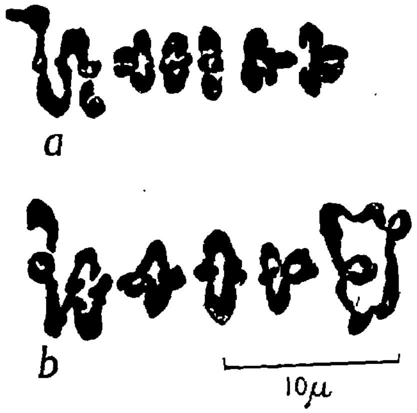

Meiotic chromosomes in Extra Rapid translocation crossed (*a*) standard, (*b*) *K* line

of the slides. Fig. (*a*) shows the meiotic chromosome complement in the hybrid between the Extra Rapid translocation and the standard line, and Fig. (*b*) shows that of the *K* line crossed the Extra Rapid translocation. Two associations of four and three bivalents are clearly seen.

The accompanying table gives further results of crosses involving the Extra Rapid translocation. These indicate that chromosomes 3 and 5 are involved, as in my original communication.

Results of crossing Extra Rapid translocation

Line	Chromosomes interchanged	Configurations
Structural Type 1	—	Association of four
,, ,, 2	1 and 2	Two associations of four
,, ,, 3	1 and 3	An association of six
,, ,, 6	1 and 4	Two associations of four
,, ,, 5	4 and 5	An association of six

From correspondence with Dr. Lamm, I learn that the two translocations in the Extra Rapid variety arose independently. Therefore, it would seem that two different translocations are involved.

The genetical evidence of Lamm[2] indicates that *GP* on chromosome 2 is involved, and that of Nilsson[3] suggests linkage with *B St* on chromosome 3, which would indicate that the Swedish Extra Rapid translocation involves chromosomes 2 and 3. The two Extra Rapid translocations, if crossed, should give an association of six since they have chromosome 3 in common.

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May 17.

[1] Sansome, E., *Nature*, 139, 113 (1937).

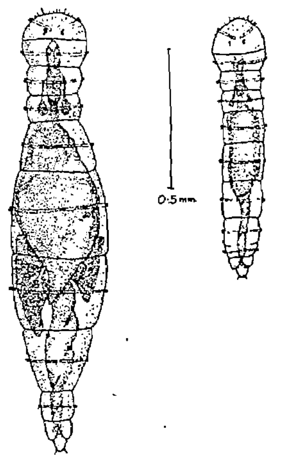
[2] Lamm, R., *Hereditas*, 35, 203 (1949).

[3] Nilsson, E., *Hereditas*, 36, 75 (1950).

An Archiannelid from South Africa

SEVERAL specimens of an Archiannelid were recently found on portions of the thallus of the prostrate alga, *Codium Stephensiæ* Dickinson, which had been kept in an aquarium for some months. They were also found to be abundant among the débris on the bottom of the tank. The *Codium* had been collected at Kommetjie on the Cape Peninsula some twenty-two miles south of Cape Town.

The little worms are members of the ge *philus* Schmidt. Members of this genus fc groups: the species of one group are usuall opaque and sexually monomorphic; the sp other are usually colourless, transparent an dimorphic. The South African specimens fa second group. The adult females are about long, and their appearance is very similar scriptions of *Dinophilus gyrociliatus* Schmid by Shearer[1] and Fauvel[2], and they differ o presence of an extra segment (if the portio constrictions constitutes a segment), an absence of any definite circum-anal ciliary males are rudimentary and never leave cocoon, where as soon as they become free egg membrane they were seen to copulate young females.



Adult (left) and juvenile (right) female of *Dinophilus gyroc* from South Africa

Considering that Fauvel[2] unites with *D. gyroc* several species formerly separated by slight ences, the points of difference shown by these African specimens do not seem to be suffic justify the making of a new species to include in spite of the fact that they have been found from the known range of *D. gyrociliatus*. Sinc differences were found to be constant in hundreds of specimens examined, they may b cient to constitute a new variety, and this proposed in a paper giving a full description specimens, to be published later.

So far as I can ascertain from the literatur disposal, this is the first record of an Arch not only from South Africa but also from the hemisphere.

My thanks are due to Prof. J. H. Day, Town, for confirmation of my identification Miss P. L. Smuts, of the Department of University of Cape Town, for identifying the of *Codium* on which the animals must ha introduced into the aquarium.

WM. MA

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University College,
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[1] Shearer, C., *Quart. J. Micr. Sci.*, 57 (1912).

[2] Fauvel, P., "Faune de France: Polychaetes sédentaires", 1927).

RTHCOMING EVENTS

Monday, July 3—Friday, July 7

PETROLEUM (at the Royal Technical College, Glasgow). "Oil Shale and Cannel Coal".

Tuesday, July 4—Friday, July 7

OF APPLIED BIOLOGISTS (at Edinburgh).—Summer

Thursday, July 6

TY OF TROPICAL MEDICINE AND HYGIENE (at Manson and Place, London, W.1), at 7.30 p.m.—Lieut.-General cArthur: "The Story of Smallpox in the British Isles".

Friday, July 7

TITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 t, London, W.1), at 8 p.m.—Dr. Lauriston S. Taylor U.S.A.): "The Measurement of X- and Gamma-Radia- ide Energy Range" (Twenty-ninth Silvanus Thompson ure).

Friday, July 7—Saturday, July 8

OCIETY (in the Lecture Theatre, George Holt Physics The University, Brownlow Hill, Liverpool).—Summer

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POINTMENTS VACANT

NS are invited for the following appointments on or ates mentioned:

LECTURER IN THE DEPARTMENT OF ZOOLOGY—The niversity College, Hull (July 8).

IN BIOLOGY (preferably with qualifications in Zoology ogy)—The Registrar, Nottingham and District Technical kespeare Street, Nottingham (July 8).

IN CHEMISTRY—The Principal, Acton Technical College, , Acton, London, W.3 (July 8).

IN CHEMISTRY, a LECTURER IN METALLURGY, a LECTURER ATICS, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF investigations at high frequencies—The Registrar, Birm- ntral Technical College, Suffolk Street, Birmingham 1

R IN TELECOMMUNICATIONS in the Department of Physics mmunications, and a LECTURER IN PHYSICS—The Clerk ernors, Woolwich Polytechnic, Woolwich, London, S.E.18

H FELLOW IN INDUSTRIAL METALLURGY, to work in the lting and casting of metals—The Secretary, The University, m 3 (July 8).

ASSISTANT with experience in Food and Drug Analysis, al reference to *spectrography and spectrophotometry*, and a L ASSISTANT with particular interest in the field of spectro- y and spectrography, in the Laboratory of the Public The Secretary and Registrar, The University, Bristol (July 8).

TICIAN (with University degree with first- or second-class or a degree of equivalent standard, and wide experience of work) to the Secretary of State for Scotland's Department tablishment Officer, S.H.D., Room 364, St. Andrew's House, h 1 (July 8).

ER IN BIOLOGY (with good degree in Botany with Zoology liary)—The Principal, Norwood Technical College, Knight's don, S.E.27 (July 8).

INARY PATHOLOGIST (Grade II), and VETERINARY INSPECTORS II), in the Veterinary Department of Cyrenaica—The Ministry ur and National Service, Technical and Scientific Register k House, Kingsway, London, W.C.2, quoting G.184/50A).

PAL SCIENTIFIC OFFICER IN THE SHIP DIVISION OF THE PHYSICAL LABORATORY, TEDDINGTON (with first- or second- ours degree, preferably in naval architecture, or high pro- ttainments in that subject, and experience of research work dynamic or aerodynamic problems)—The Secretary, Civil mmission, Scientific Branch, 7th Floor, Trinidad House, Old n Street, London, W.1, *quoting No.* 3135 (July 13).

ONIC ENGINEERS or PHYSICISTS (unestablished, Experi- fficer grade) in the Royal Aircraft Establishment (Instru- Dept.), Farnborough, Hants—The Ministry of Labour and Service, Technical and Scientific Register (K), York House, , London, W.C.2, quoting D.170/50A (July 14).

STS or ELECTRONIC ENGINEERS (Experimental Officer grade, hed) at a *Ministry of Supply Research and Development* ent near London, for work in (*a*) electronic instrumentation , with high-speed photographic technique and strain gauges, experimental work involving small mechanism and instru- experience of practical spectroscopy and some familiarity ronic techniques, (*d*) radio and electronics—The Ministry of nd National Service, Technical and Scientific Register (K), se, Kingsway, London, W.C.2, quoting A.158/50 (July 14).

NT IN THE DEPARTMENT OF ANIMAL GENETICS—The Secre- University, Edinburgh (July 15).

STRATOR IN THE DEPARTMENT OF PHYSICS—The Registrar, ty College, Singleton Park, Swansea (July 15).

RER IN CHEMISTRY (main subject should be physical chem- ferably with experience in colloid chemistry), and a LECTURER GY (with qualifications mainly on the zoological side, with l experience)—The Registrar, University College of North shire, Keele, Stoke-on-Trent (July 15).

ANICAL and AERONAUTICAL ENGINEERS (Senior Experimental grade, unestablished) at the Royal Aircraft Establishment res Department), Farnborough, Hants, in the following fields : (1) fatigue of aircraft structures, (2) strain gauge installations raft calling for electronic experience with ability to adapt *instruments for use* in this connexion on the ground and in flight, (3) aircraft accident investigations, (4) static aero-elastic, flutter and vibration problems of aircraft—The *Ministry of Labour and National* Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.300/50A and Post No. (July 15).

RESEARCH FELLOW IN THE DEPARTMENT OF MINING, to take charge of a team carrying out research on the chemical constitution of coal—The Secretary, The University, Birmingham 3 (July 15).

SENIOR EXPERIMENTAL OFFICER (Ref. F.355/50A), with qualifications in engineering or chemical engineering, preferably to Degree standard, with knowledge of handling chemicals and ability to control industrial staff, and an EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (Ref. F.356/50A), with at least H.S.C. or equivalent qualification, with experience in engineering and/or chemistry and *ability to work well in a team of scientific and industrial workers*, at a Ministry of Supply Research and Development Establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 15).

SENIOR SCIENTIFIC OFFICER (unestablished) (with a good honours degree in civil engineering or equivalent qualification, and have *studied the effect of static loads either in roads, airfields or foundations*), at a Ministry of Supply Engineering Establishment in Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.276/50A (July 15).

TECHNICAL OFFICER (woman, with degree in chemistry and administrative or industrial experience) in the Technical and Scientific Register—The *Ministry of Labour* and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.380/50A (July 15).

PRINCIPAL SCIENTIFIC OFFICERS IN THE MECHANICAL ENGINEERING RESEARCH ORGANISATION OF THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH : (*a*) Engineer for research into the properties of engineering materials at high temperatures, (*b*) an Engineer with *experience of the application of research in industry to lead research* into generic problems of mechanical engineering in the Division studying lubrication, wear, and the mechanical engineering aspects of corrosion, etc., and (*c*) a Physical Chemist to lead a research group studying the fundamental factors underlying the process of wear and its modification by the presence of lubricants—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, *quoting No.* 3141LA (July 18).

LECTURER IN NATURAL HISTORY (with special qualifications in vertebrate zoology or comparative physiology)—The Secretary, The University, Aberdeen (July 20).

ASSISTANT LECTURER IN CIVIL ENGINEERING—The Registrar, Queen Mary College, Mile End Road, London, E.1 (July 22).

RESEARCH OFFICER (with University degree with honours, with *physics and/or mathematics as a major subject or equivalent qualifications*, and experience in some branch of theoretical physics applicable to low-temperature research) in the Division of Physics, National Standards Laboratory, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 2900 (July 22).

SCIENTIFIC OFFICERS (with first- or second-class honours degree in physics and *good general electronic knowledge and experience*), at Ministry of Supply Research and Development Establishments near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.172/50A (July 24).

SENIOR EXAMINER (male, with honours degree in physics with chemistry as a subsidiary subject, or an honours degree in chemistry *with physics as a subsidiary subject) in the Ministry of Fuel and* Power—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3126 (July 28).

BIOPHYSICIST to the Clinical Research Unit of Alfred Hospital, Melbourne—The Agent-General for Victoria, Australia House, Strand, London, W.C.2 (Melbourne, July 31).

DE BEERS CHAIR OF ENGLISH LANGUAGE in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

EMBRYOLOGIST or IMMUNOLOGIST in the Department of Zoology, to undertake research on fertility in mammals—The Secretary and Registrar, University College of North Wales, Bangor (July 31).

PROPAGATOR (with National Diploma in Horticulture or an equivalent qualification, and a sound *practical knowledge of the propagation* of fruit plants)—The Secretary, Research Station, Long Ashton, Bristol (July 31).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, University College, Dundee, to undertake work on the thermodynamics of solutions—The Registrar, The University, St. Andrews (July 31).

AGRICULTURAL SUPERINTENDENTS for extension work, H.M. Colonial Service, Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. *32055/19/50* (August 15).

SENIOR LECTURER IN APPLIED AND INDUSTRIAL CHEMISTRY, and a LECTURER IN ORGANIC CHEMISTRY, in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.2 (August 15).

PROFESSOR OF FIELD HUSBANDRY, and a PROFESSOR OF SHEEP HUSBANDRY, at Massey Agricultural College, Palmerston North, New *Zealand—The Secretary, Association of Universities of the British* Commonwealth, 5 Gordon Square, London, W.C.1 (September 21).

ANALYST, preferably experienced in the analysis of non-ferrous metals and alloys—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

ASSISTANT EXPERIMENTAL OFFICER (with a degree in science or equivalent qualifications) to assist with the Drosophila research *programme—The Executive Assistant*, Animal Breeding and Genetics Research Organisation, Kings Buildings, West Mains Road, Edinburgh 9.

ASSISTANT LECTURER IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Secretary, Royal Technical College, Glasgow.

ASSISTANT LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING, and a DEMONSTRATOR IN CHEMISTRY—The Registrar, The University, Nottingham.

BIOCHEMIST (with degree or equivalent in chemistry) in the Department of Pathology—The Secretary, Welsh National School of Medicine, 34 Newport Road, Cardiff.

BIOCHEMIST (with honours degree in chemistry or equivalent, and extensive experience in hospital biochemistry)—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex.

GRADUATE LECTURER IN BIOLOGY in the Chemistry Department—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

GRADUATES (with first- or second-class honours in physics or chemical engineering) to work on the application of physics in fuel technology, including temperature and fluid flow measurement, properties of suspensions of particles and the general application of physical techniques—The Secretary, British Coal Utilisation Research Association, Randalls Road, Leatherhead, Surrey.

HEAD OF THE DEPARTMENT OF HYGIENE AND PUBLIC HEALTH—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

LECTURER OR ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, University College, Exeter.

LECTURER IN BIOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

LECTURER IN BOTANY (with particular interest in plant physiology) for classes up to B.Sc. (Special) Degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN PHYSICS (with honours degree in physics) in the Department of Natural Philosophy—The Secretary, Royal Technical College, Glasgow.

MALARIA FIELD OFFICER by the East Africa High Commission—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.25969/3A.

PHYSICIST (honours graduate preferably with research experience) primarily for work on physical properties of powders and suspensions and methods of processing such materials, a CHEMIST (graduate) primarily for work on surface chemistry of fine powders and analytical work, and an EXPERIMENTAL ASSISTANT (of Intermediate B.Sc. standard)—The Director of Research, British Whiting Federation, 245 Ampthill Road, Bedford.

RESEARCH FELLOWSHIP for research into problems connected with heating and ventilating—The Secretary, Institution of Heating and Ventilating Engineers, 75 Eaton Place, London, S.W.1.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

B.I.O.S. Surveys Report No. 22: The Paint Industry in Germany during the Period 1939–1945. By Neil R. Fisk and H. W. Brown. Pp. 153+4 plates. (London: H.M. Stationery Office, 1950.) 3*s*. net. [274

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1948. Northern Division. Report by T. A. Jones. Pp. 39. (London: H.M. Stationery Office, 1950.) 1*s*. net. [274

Association of British Insecticide Manufacturers. Directory, 1950. Pp. 124+xxvi. (London: Association of British Insecticide Manufacturers, 1950.) Free. [15

British Non-Ferrous Metals Research Association. Thirtieth Annual Report, April 1950. Pp. 64+2 plates. (London: British Non-Ferrous Metals Research Association, 1950.) [15

Institution of Electrical Engineers. Regulations for the Electrical Equipment of Buildings. Twelfth edition. Pp. vi+202. (London: Institution of Electrical Engineers, 1950.) Paper, 3*s*. 6*d*.; cloth, 5*s*. [15

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 18: Concrete Kerbs, Causes and Prevention of Failures. By J. A. Loe. Pp. iv+18+2 plates. (London: H.M. Stationery Office, 1950.) 9*d*. net. [25

British Standards 628–32 and 650–56: 1950, Vegetable Oils. Pp. 50. 6*s*. net. British Standard 684:1950, Methods of Analysis of Oils and Fats. Pp. 92. 7*s*. 6*d*. net. British Standard 1640:1950, Steel Butt-Welding Fittings for the Petroleum Industry. Pp. 18. 7*s*. 6*d*. net. (London: British Standards Institution, 1950.) [25

Report of the Departmental Committee on Children and the Cinema. (Cmd. 7945.) Pp. v+109. (London: H.M. Stationery Office, 1950.) [95

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Magic, Craftsmanship and Science. The Frazer Lecture delivered at Liverpool, 10th November 1949. By V. Gordon Childe. Pp. 19. (Liverpool: University Press of Liverpool, 1950.) 1*s*. [95

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Berichte der Naturforschenden Gesellschaft zu Fre Herausgegeben von Prof. Dr. M. Pfanmenstiel. Band, Pp. 320. (Freiburg i. Br.: Naturforschenden Gesellschaft

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Contributions from the United States National Herbar 29, Part 9: New Grasses from Mexico, Central America, an By Jason R. Swallen. Pp. v+395–428. (Washington, D.C. ment Printing Office, 1950.) 15 cents.

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Astronomical Papers prepared for the Use of the America eris and Nautical Almanac. Vol. 11, Part 2: First-Order Mars. Pp. 223–500. (Washington, D.C.: Government Office, 1949.) 1.50 dollars.

United States Department of the Interior: Geologica Bulletin 948–C: Chromium Deposits of Boulder River Are grass County, Montana. By A. L. Howland, E. M. Garrels a Jones. (Strategic Minerals Investigations, 1945.) Pp. iv plates 33–38. 1.25 dollars. Bulletin 955–B: Structural the Gold Deposits of the Cripple Creek District, Telle Colorado. By A. H. Koschmann. (Contributions to Economic 1947.) Pp. iii+19–60+plates 3–4. 1.25 dollars. Bulleti Geology and Manganese Deposits of the Lucifer District, of Santa Rosalia, Baja California. By Ivan F. Wilson a Veytia. (Geologic Investigations in the American Republic Pp. iv+177–234+plates 37–54. n.p. Bulletin 963–A: Some Investigations in Southeastern Alaska. By W. S. Twenhof Reed and G. O. Gates. Pp. iv+45+2 plates. 40 cents. 966–C: Geophysical Abstracts 138, July–September 1949 (N 11202–11441). By Mary C. Rabbitt, V. L. Skitsky and S. T owsky. Pp. iii+167–251. 25 cents. (Washington, D.C.: Gov Printing Office, 1949.)

United States Department of the Interior: Geological Professional Paper 214–D: Petrography of the Island of By Gordon A. Macdonald. Pp. iii+51–96+plates 11–14. (W ton, D.C.: Government Printing Office, 1949.) 35 cents.

United States Department of the Interior: Geological Water-Supply Paper 1029: Ground Water in the Jordan Utah. By G. H. Taylor and R. M. Leggette. Pp. vi+357+14 1.50 dollars. Water-Supply Paper 1030: Quality of Surface of the United States, 1945. Pp. vi+335. 60 cents. Water- Paper 1051: Surface Water Supply of the United States, 1946, North Atlantic Slope Basins. Pp. xiii+676. 1.50 dollars. Supply Paper 1069: Public Water Supplies in Central and Central Texas. By R. W. Sundstrom, W. L. Broadhurst an Dwyer. Pp. vii+128+1 plate. 75 cents. Water-Supply Pape Water Levels and Artesian Pressure in Observation Wells United States in 1946, Part 1, Northeastern States. Pp. vi 1.25 dollars. Water-Supply Paper 1075: Water Levels and A Pressure in Observation Wells in the United States in 1946, Northwestern States. Pp. v+192. 40 cents. Water-Supply 1076: Water Levels and Artesian Pressure in Observatio in the United States in 1946, Part 6, Southwestern States an tory of Hawaii. Pp. vi+316. 65 cents. Water-Supply Pape Surface Water Supply of the United States, 1947, Part 7 Mississippi River Basin. Pp. xi+419. 1 dollar. Water-Supp 1089: Surface Water Supply of the United States, 1947, Colorado River Basin. Pp. ix+418. 1 dollar. Water-Supp 1090: Surface Water Supply of the United States, 1947, The Great Basin. Pp. vii+196. 45 cents. (Washingto Government Printing Office, 1949.)

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SCIENTIFIC RESEARCH IN INDUSTRY

THE debate in the House of Commons on May 5 on Mr. Philips Price's motion that there should be the fullest possible development and utilization of Britain's exceptional scientific resources and man-power, with the view of ensuring effective progress in industry and agriculture and in the development of the Colonies, and a material improvement of our economic position in the world, served a very valuable purpose. Many aspects of the question were discussed in the debate, including technical and higher technological education, the balance, distribution and remuneration of scientific and technical man-power and the general structure of our research organisation. In particular, Mr. Price raised the question as to how far the results of research are being effectively used in the factories. He referred both to the research associations and the research stations of the Department of Scientific and Industrial Research, and asked whether private industry is making the full use that it could do of work done in such research stations.

Mr. Price's reference to the research associations suggested that the chief doubt in his mind concerning them is whether there is a sufficiently effective liaison between them and the industries they serve. Mr. Erroll, who followed, however, raised the more fundamental issue whether the research associations are inherently fitted for the really creative and inventive work on which industrial progress finally depends. He thought that research associations perform valuable functions, but that their field is limited, and that they could not make any very constructive contribution to inventiveness. Mr. Erroll was further concerned as to whether there is sufficient collaboration and co-ordination of the different research stations and research departments of the various Departments of State. Other speakers, like Mrs. Eirene White and Mr. Carr, seemed to be more satisfied with the work of the research associations, and welcomed the increasing interest which the trade unions are taking in their work. Mr. Carr made the point that for the small- or even medium-sized firms to set up independent laboratories might lead to waste of scientific man-power; but he appeared to overlook the obstacle to the utilization of scientific knowledge, whether obtained by the work of a research association or in some other way, which is presented by the lack of scientifically trained men, who can understand the significance of such results, on the staffs of the small firms. Later in his speech, however, he recognized the need for management to understand the language of scientific men, and for directors and executives to have a general scientific training so that they are receptive to scientific ideas.

To overcome this difficulty of bringing scientific information to the smaller progressive firms, Mr. Fort suggested that institutions such as chambers of commerce should give fellowships of substantial amounts in certain firms, on condition that they employ a scientific man of the highest standard who would be encouraged to maintain his academic contacts as well as to gain the widest possible knowledge of the industry and its problems. Mr. Fort was less critical of the research associations than was Mr. Erroll; but he referred to the alternative co-operative method of the Mellon Institute, though he thought that experience in the United States may not be a safe guide as to the success of such an experiment in Great Britain. Some speakers laid considerable stress on the value of bodies like the British Institute of Management, and urged that more attention should be given to the study of human relations and to the organisation of research in social science, though it was not suggested that the research associations themselves should enter this field.

On that last point, the Lord President of the Council, replying to the debate, held out no immediate prospect of the establishment of a research council for the social sciences as suggested by the Clapham Committee, though he wished to encourage and develop such activities as those of the Panel on Human Factors in Industry and various institutions engaged in the broad field of social science. Mr. Morrison also agreed as to the value of the management research associations. Referring to the research association movement in general, he stated that the Government and the Department of Scientific and Industrial Research as well as the research associations are making the greatest efforts at improvement, and that there is an increasing degree of co-operation; but he did not face the crucial question whether this is the most effective form even of co-operative effort in which the resources of Great Britain can be expended.

In this debate the critical questions with regard to the organisation of co-operative research effort were neither raised nor pressed. That cannot be said of the study of co-operative industrial research which Prof. R. S. Edwards has given in his "Co-operative Industrial Research"*. The book was written before his appointment last October to the Advisory Council for Scientific and Industrial Research; but while it purports to limit itself to the economic aspects of the research association, it asks many of the fundamental questions that must be answered before we can appraise fully the place of the research associations in the industrial economy of Great Britain to-day and decide upon their future. It is a contribution of first-class importance, though of the nature of things it cannot be a substitute for that authoritative review which the Department of Scientific and Industrial Research, if not the Advisory Council on Scientific Policy, should be considering in view of the comments of the Select Committee on Estimates. Sir Henry Tizard's presidential address to the British Association in 1948 indicated that he is prepared to attempt the fundamental and comparative inquiry into the research association movement in relation to other forms of co-operative industrial research, and Prof. Edwards has done something towards clearing the way.

One feature of Prof. Edwards's study that should be noted is his attempt to ascertain, by means of a fairly wide canvas of industrial opinion, what industry thinks of the research associations. There were some pointers in the discussion which followed Mr. R. M. Winter's and Dr. L. B. Pfeil's papers on relationships of research associations, Government departments and the universities at the Conference of Industrial Research Directors and Managers arranged by the Industrial Research Committee of the Federation of British Industries in March 1949; but otherwise there is practically no published opinion. Prof. Edwards's book provides a useful insight into industrial opinion on the possibilities and limitations of co-operative research, and generally corroborates what was said at the Federation of British Industries Conference. One chapter in the second part of this book examines the replies received from 225 firms to a questionnaire, and, while due regard is had to the limitations of this method of inquiry and it is recognized that the evidence is insufficient to support the categorical statement that the research associations are worth their cost, Prof. Edwards believes that the inquiry supports the financial evidence that the associations are progressing. His own impressions are broadly in line with the statistical evidence that the research association is a perfectly sound industrial institution.

The qualification to be given to that statement will depend largely on the view taken of the functions of the research associations and of the scope of the programmes which they should pursue. It is here that the critical questions arise, and the fourth part of the book—rather more than one-third—in which they are examined, is of most interest at the present time. The economic aspects which Prof. Edwards examines in some detail in the second and third parts of his book are purely secondary until the larger issues are resolved, though it may be noted that his study leads him to conclude that in broad conception the scheme propounded by the Department of Scientific and Industrial Research was sound and that in general the research associations are now well placed financially. As regards the future, he gives clear reasons why a compulsory levy should not in general be adopted as a device for financing research associations; but he points out that subsidies to established associations are no longer justified on the ground that British industry undervalues their work. Government contributions to research associations, apart from assistance to promising new associations meeting a recognized need, could be justified if for specific reasons of public policy it is desired to stimulate their activities over and above the rate which would come about commercially.

Prof. Edwards's rather full analysis of the determination of subscriptions to a research association, although, as he admits, not a matter of great public importance, is of interest as indicating the great complexity of the problem and the improbability of the associations becoming independent, as a whole, of Government support. He sees little need for change in the basic structure of research association subscriptions; but the financial aspect is, as already implied, of secondary importance compared with the extent of the demand the associations make on the nation's resources in scientific or technical man-power or materials. That demand must be justified relative to other demands, if industrial research and development are to be on the scale they should be in order to make their most effective contribution to economic recovery.

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* Co-operative Industrial Research: a Study of the Economic Aspects of the Research Associations Grant-aided by the Department of Scientific and Industrial Research. By Prof. Ronald S. Edwards. Pp. xiv+285. (London: Sir Isaac Pitman and Sons, Ltd., 1950.) 20*s*. net.

That the programmes of different research associations may overlap Prof. Edwards regards rightly as of slight importance. It may even possess advantages which offset any apparent waste of effort or material; and his warning that attempts to eliminate overlapping by excessively large organisations or ponderous schemes for co-ordination may lead to more serious ills should be noted. This point was overlooked in the recent debate, though there also stress was laid on the value of research associations pursuing some fundamental research. Prof. Edwards sees in such investigations one justification for the Government grant, and also the advantages not only of solving problems economically in the long run but also of sustaining the quality of the staff and the scientific standing of the association.

Here questions of relations with the universities may arise; but these are not discussed by Prof. Edwards. He recognizes that research into the constitution and behaviour of materials, on which the associations have concentrated, is particularly suited to co-operative research, and that with the creation of new materials and more powerful analytical devices, its importance is unlikely to contract. In regard to standardization and the certification of products, however, a certain amount of caution is necessary. Work on the scientific and technical aspects of specification and on the devising of standards is, in his view, a valuable function of research associations; but the asssociations will probably exert more influence in the long run if they limit themselves to the solution of the scientific and technical problems which fall properly within their field of expert knowledge.

There are other comments on the programme of the research associations which deserve to be noted. Market research in general is, in Prof. Edwards's opinion, an inappropriate study for the research associations, and while at least one or two research associations contemplate undertaking cost studies, in view of the scarcity of applied economists competent to give a lead in those fields where technical and economic questions merge, he recommends that in such problems the associations should seek the collaboration of university economists. Similarly, he recommends caution in moving into the field of human relations, if indeed the associations enter it at all, until it becomes clearer from the work of the specialist institutions what main lines of attack are likely to be profitable. Prof. Edwards considers that research associations should co-operate in those operational research studies which are most closely associated with the scientific and technical aspects of their industries, but he gives a timely warning that operational research is unlikely to yield in industry the same spectacular results that it yielded in the War; however, he would give full weight to the information, advisory and testing services of the associations in any schemes of expansion. He regards the freedom of members to leave an association if they are not satisfied as highly important, and he points out that the passing of the Industrial Organisation and Development Act, 1947, has gravely endangered this freedom.

Prof. Edwards does not give any adequate comparative discussion of alternative methods of co-operative research. The reasons why sponsored research should not be undertaken by a research association are set forth lucidly, but without any indication that they do not apply with the same force to an institution of a different type, such as the Mellon Institute or the Battelle Institute. Moreover, in his brief reference to those types of institution Prof. Edwards has missed two important points. The success of certain institutions of this type such as the Institute of Paper Chemistry at Appleton, Wisconsin, may well be due as much to its location in the midst of the industry as to its academic affiliation, as indeed Dr. D. W. Hill noted in his earlier book. Location may be a more important factor in the success or failure of a research association than Prof. Edwards indicates, and proximity to the industry served may be far more vital than proximity to another research association with which facilities or services may be shared.

This is closely related to another point not mentioned by Prof. Edwards. One argument against the conduct of sponsored research by research associations rests on the embarrassment arising out of secrecy of a particular project. Can we be satisfied that this factor does not operate in another way to hinder the selection of the most appropriate projects of research for an association ? The effective use of man-power and of material resources must depend on the right choice of projects. This is one of the essential questions to which an answer must be found if we are to form a sound judgment on the value of the associations. Its importance is underlined by Prof. Edwards's remarks on bridging the gap between an association and its members, and by his insistence that the most important factor in the future development of the research associations will be the quality of the staff they succeed in attracting. It is imperative that members of the research associations should appreciate that the quality of men is of prime importance alike for the work they do, and for their influence on the standing of the association and its ability to attract able young workers. The associations must be able to offer conditions and opportunities which will attract good men. But the very fact that they will be in strong competition with the universities, technical colleges, the Government services and industry itself makes it essential that the nation should be satisfied that wise and efficient use is made of the talent so attracted, and that service is rendered to the community that would not be rendered better in some other way.

Prof. Edwards is really fully aware of the importance of other forms of organisation. While he is clear that, given capable direction and competent staff, the co-operative research association is a valuable form of industrial institution, he points out that it does not follow that the research association movement should be developed to the neglect of other forms of organisation. Moreover, we are in danger of regarding industrial co-operation as a virtue in itself even when it is at the expense of efficiency. Here he is particularly concerned with the future of those associations which serve the nationalized industries. Only time can show whether the associations will maintain the measure of independence which he regards as vital when their finance is dominated by one authority. Finally, he urges that, in research, enterprise and individualism are first conditions of success. If, he says, the schools, universities and other institutions which play a part in developing and training our industrial leaders fail to kindle the spirit of enterprise, if the legal, social and economic framework in which industry works is not conditioned so as to make policies of restriction unpopular and unrewarding, we shall decline as an industrial nation even though we have the finest research and other industrial institutions in the world.

In this highly important book, Prof. Edwards has made very clear the factors upon which the success of the research associations within their delineated field depends. With wise management and competent staff they are capable of making a significant contribution to industrial development, by direct discovery and invention, by the infusion of a scientific spirit into the industries they serve, through the migration or interchange of staff, information or liaison services or in other ways. It is for the Government to show that their contribution justifies whatever demands their work may be making upon the nation's resources of man-power, materials and equipment. Nor can any such official inquiry disregard the critical factor of the climate of opinion, to which Prof. Edwards directs attention in concluding, or the question as to how far expansion of the research associations can be allowed to proceed in competition with other forms of industrial or fundamental research or training of scientific and technical man-power.

THE STUDY OF GROWTH

The Chemistry and Physiology of Growth

By J. H. Northrop, F. O. Schmitt, K. V. Thimann, Karl Folkers, C. B. van Niel, E. S. G. Barron, P. Weiss, J. S. Nicholas, C. P. Rhoads and C. N. H. Long. Edited by Arthur K. Parpart. Pp. ix+293+4 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1949.) 36*s*. net.

THIS book is the outcome of a conference held at Princeton in September 1946. It is fairly clear, from the nature of the papers, that the speakers were expected not to confine themselves to the presentation of facts already known about their topics, but were encouraged to propound new theoretical outlooks, even of a highly speculative character, and to do their best to indicate the lines along which advance may be expected. The presentation of the hopes and tentative suggestions of so many eminent workers makes a stimulating book.

Moreover, the participants at the conference were competent to deal with most of the more fundamental aspects of the phenomena of growth, although they do not, of course, all handle their material with the same authority and convincing manner. Unfortunately, also, the material is rather too inadequately prepared; one gets the impression that many of the articles, particularly those of J. S. Nicholas and C. P. Rhoads, are transcripts of shorthand records of their addresses. Thus, the references given are often not at all well chosen; there are many loose phrases, possibly excusable when spoken, but scarcely so in a published book (for example, grafts of "cells homozygous with the host", p. 238); and in several places the writing is so loaded with abstract jargon that one can only guess at what the writer is trying to say. The book is, therefore, not to be recommended to beginners.

Those who already know a fair amount about the subject can, however, derive much interest from it. It opens with a clear and stimulating discussion of protein synthesis by J. H. Northrop, which is followed by an equally exemplary paper by F. O. Schmitt on molecular morphology and growth. A short paper by K. V. Thimann on plant-growth hormones is also extremely interesting, although rather beside the main issues discussed in the remainder. K. Folkers offers for inspection a miscellaneous collection of unidentified growth-factors; C. B. van Niel suggests the desirability of further work on growth kinetics of bacteria, and E. S. Guzmann Barron gives a very interesting account of certain aspects of cellular metabolism and their relation with growth processes. One of the longest articles is that by P. Weiss on differential growth. Much of this is devoted to the elaboration of the ideas, which he has previously published, of 'molecular ecology' and of the paramount importance of surface reactions. Both these ideas seem to me to be of the right general kind, in that they attempt to phrase the problems of development in physico-chemical terms, but to neither of them is it easy to attach any very definite meaning. There seem to be no particular principles of ecology which can be applied to the molecular events in a developing cell; and the attractive phrase 'molecular ecology' still remains merely an attractive phrase. Again, it is certain that not all developmental processes take place at the cell surface; and Weiss's second thesis can only be sustained by invoking all manner of intracellular surfaces, until finally one discovers one is talking about reactions at the surface of molecules, at which point the concept of a surface-reaction also appears to have lost all specific meaning and we are back where we started.

In the succeeding chapter, Nicholas discusses the problems of organisation, but scarcely succeeds in bringing that hazy concept into very definite focus. Rhoads gives a bold and almost brash discussion of the cancer problem, based on the argument that neoplastic growth is a type of differentiation, and that normal differentiation is due to gene mutation; but, as the latter statement can only be adjudged excessively improbable (unless the phrase gene mutation is given some quite special and unusual sense), his thesis, though leading to an interesting discussion, is scarcely convincing, even when diluted to taste by dashes of plasmagenes, kappa factors, milk factors, and so on. The book ends with a short section by C. N. H. Lang on the adrenal gland, which is not very clearly integrated with what has gone before.

In sum, it must have been an interesting conference, but it does not make a very good book.

C. H. WADDINGTON

X-RAY DIFFRACTION FOR THE STUDENT

The Optical Principles of the Diffraction of X-Rays

By Prof. R. W. James. (The Crystalline State, Vol. 2.) Pp. xv+623. (London: G. Bell and Sons, Ltd., 1948.) 80*s*. net.

IT seems likely that Prof. R. W. James's book will remain for many years the standard text on the theory of X-ray diffraction. With an exception noted below, the mathematical development is full enough to offer no difficulties to the conscientious student, who will certainly welcome an alternative to the obscure brilliancy of Prof. Zachariasen's "Theory of X-Ray Diffraction in Crystals". The field covered is broad, with one chapter on the geometrical theory of diffraction by lattices, six on aspects of the theory of the intensity of diffraction, one on the use of Fourier series, one on scattering by fluids and non-crystalline solids, and one on diffraction by small or imperfect crystals.

Prof. James adopts a semi-historical approach, with obvious pedagogic advantages. The simpler and more easily understood results tend to come earlier in time, and familiarity with them is a great aid to the student when he has to grapple with the deeper theory that supersedes or includes them. Undeniably, however, it takes up more space than a single exposition on the highest level appropriate to the book. In the present volume, diffraction by a perfect crystal is treated first by Darwin's method, then Prins's, then Ewald's, and finally by Laue's extension of Ewald's method. The topic is important, and it is convenient to have all four versions to hand; but it may be felt that Prins's and Laue's treatments, with perhaps an indication of the points where they mark an advance over Darwin's and Ewald's, would have been quite sufficient. There are other less-important repetitions of doubtful value.

Space so saved could have been used to advantage in the chapters on scattering and anomalous dispersion. It is here that I feel Prof. James to be less successful than in the rest of his book. The mathematical development is compressed to the point where it cannot well be followed without the original papers; but it is more voluminous than is necessary for a critical exposition of assumptions and results. The assumptions and results are, however, clearly expressed, and the intervening material may easily be ignored, or used as a commentary when interest or necessity leads one to the original papers.

The chapter on the effects of thermal motions is clear and detailed, and it is interesting to learn from the preface that it had been written in practically its present form in 1936, before the burst of interest in diffuse scattering in the early years of the War. The only important alteration needed was the addition of a survey of the experiments that confirmed the theory so beautifully. Thermal scattering adds yet another example to the list of theories developed well in advance of techniques capable of confirming them —the theory of space groups and of dispersion are others in the field of X-ray crystallography. The Fourier-series method of representing periodic functions is fully explained, and is used as a basis both for Laue's dynamical theory of diffraction and for methods of crystal-structure determination. The latter are treated comparatively briefly, perhaps because they belong more properly to/the projected Vol. 3 of Sir Lawrence Bragg's "The Crystalline State". Patterson projections and Harker sections are included; but the manuscript was completed too early for any mention of steepest descents or sign-determining inequalities. The chapter on diffraction by fluids and non-crystalline solids is good, and stress is laid on the reasons for the differences in behaviour at low angles, though there is no mention of Guinier's work on low-angle scattering. In the final chapter diffraction by small crystals is treated fully, and its formal identity with scattering by a gas is made clear. This chapter also includes the related problems of scattering by imperfect and distorted crystals and by partially oriented structures like organic fibres.

Vectors are used throughout, and the notation is generally clear, though the expression ($\mathbf{r}_n - \mathbf{r}_m \,.\, \mathbf{S}$), or its equivalent, occurs frequently in situations where it could be replaced by $(\mathbf{r}_n - \mathbf{r}_m).\mathbf{S}$ with greater clarity and no increase in the number of symbols. (Parentheses are not part of the notation for a scalar product.) A few misprints and slips have been noted, but none likely to cause more than a moment's hesitation. Perhaps the most important is on page 476, where it is stated that the distances between centres of close-packed spheres are given by $\sqrt{(h^2 + k^2 + l^2)}$ times the diameter of the spheres. There are bibliographies at the end of each chapter, with an average of about fifty entries, mostly earlier than 1940, and in the whole book there are only two or three later than 1943. A curious omission occurs in Chapter 10, where four pages of text are devoted to a paper not included in the bibliography. These are minor blemishes, however, and do not detract appreciably from the value of this important conspectus of the theory of X-ray diffraction.

A. J. C. WILSON

SOME SELECTED PROBLEMS IN RADIO AERIALS

Radio Aerials

By Prof. E. B. Moullin. (International Monographs on Radio.) Pp. xi+514. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 50*s*. net.

THIS volume is the second in the series of "International Monographs on Radio". It mainly describes the author's theoretical and experimental investigations during the Second World War of certain types of aerial systems. The presentation and treatment of the material have been markedly influenced by the author's outlook and his particular approach from the field equations, which will prove to be stimulating to some readers, but may be a defect in the eyes of others. It is, however, felt that the title should have indicated the restricted scope of the topics considered, which represent only a fraction of the subject of radio aerials.

The first two-thirds of the book is theoretical. Chapter I introduces the electromagnetic theory used in the later chapters, and mixed C.G.S. units are used throughout. The majority of the problems considered involve cylindrical co-ordinates, and the properties of Bessel functions are accordingly presented. Chapter 2 deals with curtain and in-line arrays, and contains the calculation of the power gains of typical arrays and of the radiation resistances of their elements using the induced-E.M.F. method. As an alternative method of calculating the power radiated by an aerial, the integration of the Poynting vector over a sphere of large radius is briefly treated. On p. 114 the well-known integral involved in the radiation resistance of a half-wave dipole is incorrectly stated and is not evaluated.

Chapters 3, 4 and 5 deal with the properties of reflectors having the form of an infinite flat sheet, a V and a semi-infinite sheet; together with the two following chapters on problems involving cylinders, they form the most valuable part of the theoretical section of the book. However, the relatively large number of errors in the mathematics and the somewhat laboured treatment of parts of the analysis may prove a hindrance to the radio engineer who is not well equipped mathematically. The fundamental topic of the single isolated aerial is not introduced until Chapter 8, and it is unfortunate that Section 8.2 on the radiation resistance and power gain of a linear aerial is inaccurate—Fig. 8.6 has the ordinate axis incorrectly labelled, and Table 8.1 gives the radiation resistance of a dipole referred to the current antinode and not to the mid-point as stated.

The more exact approaches to the impedance of a linear aerial given by various workers during the past twelve years receives scant attention in Section 8.4, and it is felt that a useful opportunity to give a comparative summing-up of these theories was missed. It is surprising that the author still regards as controversial the identity of the resistance of an aerial in the transmitting and receiving conditions. Chapters 9–14 constitute the experimental section and also contain some fresh theoretical material. These chapters contain very useful information on the practical design, the performance and the testing of aerial arrays and parabolic reflectors.

In summing up, it is suggested that the value of a future edition of the book would be enhanced by a reduction of its length, which would be possible without a sacrifice of useful information, and by a fuller presentation of the established results for the single aerial which forms the basic element of any practical array.

R. E. BURGESS

A FISH FARMER'S COMPANION

Fortschrittliche Karpfenteichwirtschaft

Ergebnisse 20 jähriger Untersuchungen auf dem Gebiete der Teichforschung. Von Prof. Wilhelm Wunder. Pp. vi+385+11 plates. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele), 1949.) n.p.

THIS is a thorough treatise on carp farming in which almost half the book is devoted to the food of the carp, whether natural or artificial. In Chapter 2, the principles controlling fish production in carp ponds are set out in their complex interrelationships of stock density, natural food (stimulated by fertilization and cultivation) and added fodder. It is rather surprising to find how important a part is played by the zooplankton as a natural food for the carp. The carp tends to become increasingly a macroplanktonic feeder as it grows larger and older. The weighted percentage of zooplanktonic food, in the total food taken, increases from 22 in the first, to 75 in the fourth year, with a corresponding decrease in bottom and littoral organisms. The latter, however, play an important part in late summer, autumn and winter, when the plankton has died down. In poor and neglected ponds also, where the plankton shows only feeble development and dies away early, the carp are forced to rely almost wholly on bottom and littoral organisms, of which chironomids are the most important.

The author shows the importance of a period of dry fallow; and green manuring, which may take the form of flooding a pond in which a land crop is growing, is recommended as providing a substratum for chronomids and other fish food. For the stimulation of the plankton, the colour of which will afford the best indication of the fertilizer requirements, organic manures may be used; but, owing to their scarcity, by far the greater space is devoted to inorganic manures. However, it is interesting to read the author's approval of keeping ducks in fishponds. These birds do not harm healthy and vigorous fry, and their droppings are a valuable manure.

Among the inorganic manures, the greatest importance is attributed to lime, and next to phosphate. Superphosphate can produce an average increase of yield of 96 per cent, and repay its cost 1,000 per cent. The dosage required is small, of the order of 1 cwt. per acre annually. Potash produces no certain improvement except perhaps in very poor ponds. The same uncertainty applies to nitrogenous fertilizers—an interesting difference between agriculture and aquiculture. Unlike phosphate, which when used together with lime is the most profitable fertilizer, nitrogenous fertilizers do not give consistent increases in the yield of ponds. Recent work on the fixation of atmospheric nitrogen by De[1] and Fogg[2] proves that very substantial amounts of nitrogen can be fixed, in bacteria-free culture, by blue-green algæ, and Wunder shows that *Anabœna*, the blue-green algæ chiefly investigated by De and Fogg, is a dominant planktont in fishponds. These authors found, however, that nitrogen fixation is inhibited by the presence of readily available combined nitrogen; it seems, therefore, that the addition of expensive nitrogenous fertilizers can make little difference to the yield of a pond.

In a section on fodder for carp, the author shows that a balanced ration of protein and carbohydrate gives the best results; he describes the value of the potato as carp food, especially in well-cultivated and fertilized ponds where abundant protein, in the form of zooplankton, is already present. The artificial feeding of carp may double the yield, yet most of the fodders listed are suitable for direct human consumption. In few territories is there a readily available cheap fodder, surplus to human requirements; and surely the value of fish farming, as a technique, lies in the rapid and complete synthesis of cheap organic and inorganic manures into first-class protein by way of a short food-chain.

Chapter 5 deals with changes of body form due to the environment (*Hungerform* and *Mastform*); but Chapter 7 shows that hereditary differences closely resemble these environmental differences. Both, again, must be considered in relation to *Lebensraum*, far too briefly discussed. It is easy to understand, but difficult to explain, why small ponds produce small fish, and large ponds large fish; Fig. 52, for example, compares a three-year old fish weighing 34 gm. from a small pond, with a one-year old fish weighing 610 gm. from a large pond. In a future edition, I would like to see *Lebensraum* more fully discussed, and its effects distinguished from hereditary and environmental factors which make 'bad-doers' among pond fish.

C. F. HICKLING

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[1] De, P. K., *Proc. Roy. Soc.*, B, 127, 121 (1939).

[2] Fogg, G. E., *Brit. J. Exp. Biol.*, 19, 78 (1943).

THE BELL TELEPHONE LABORATORIES*

By DR. MERVIN J. KELLY
Executive Vice-President

THE operations involved in applying science to the instrumentation of man's pursuits have, with time, become increasingly complex, and many men with a variety of training and interests are involved in any single undertaking. Telecommunications and the equipping of the Services with the most modern and effective instruments for their many tasks in warfare are two sectors of great complexity. It is with these two areas that Bell Telephone Laboratories is concerned. As an institute, it has a charter that gives it a scope in these operations that is unique in its breadth. We have therefore been able to observe, study and modify the groupings and relationships of the men of different interests and training involved in the procedures from our frontiers, that overlap with pure science, to the manufacture of the facility and its most effective application by the using organisation.

Over the years, this development of men, methods and organisation has brought rewards in increased effectiveness—new facilities created that might otherwise have been long delayed; facilities placed in the user's hands that more completely meet his needs and at lower cost. At the same time there has been a steady improvement in the development and use of men, which not only has made for increased output but also has contributed to their satisfactions and happiness in work.

The present uncertain conditions and political state of the world are forcing each of the democratic countries to maintain the maximum of national strength; there is probably no area where strength is so vital as that of applied science and technology. Our Laboratories, as an institute of creative technology, are an important element of national strength, both for normal peace-time economy and for war. Much of its strength is due to the integration of all functions of technology into a single living organism. For this reason I present the Laboratories here from that point of view, stressing organisation, men and methods.

With the growing complexity of technology there has evolved an essential, interlaced and ordered chain of events in industry between the initial step of research and the terminal operation of manufacture. In order to stress the continuity of this events-chain of technology from research to engineering of product into manufacture and to emphasize their real unity, I speak of them as the single entity 'organised creative technology'. I am using the Bell Telephone Laboratories and its operations as an exemplification of this unity.

The Bell Telephone Laboratories is an organisation of some six thousand scientific workers, engineers and supporting staff—2,200 are scientific men and engineers. It serves the Bell System—an operating or service organisation which provides nation-wide telephone service for the United States.

The Laboratories provide the Bell System with new communications technology and the information for its implementation with new systems and facilities. Its work begins at the forefront of applied science, extends across the entire scope of creative technology, through research, development, design and engineering. The end-products of its programmes are the designs and specifications for manufacture of the technical facilities that it has created and the engineering practices to be followed in their operation and maintenance.

The complete operations of creative technology fall into three general areas. This division applies not only to the operations but also to the types of men and their training. Some industries separate these three areas in the organisation structure within the corporation and in their location. The Bell System has combined all of them into one integrated unit—our Laboratories. This integration has made possible a most intimate interrelation of the men of all areas and their work. I am sure that it has contributed greatly to overall planning, the development of men, and the efficiency of operations.

The first area includes all research and fundamental development. This is our 'non-programmed' area of work. It provides the reservoir of completely new knowledge, principles, materials, methods and art that are essential for the development of new communications systems and facilities. Arising in the course of the work and forming an important part of it are those creative concepts that constitute invention.

Its programme extends across all sectors of science that may contribute to the advancement of the communication art. They are carried out in sufficient volume so that there is the minimum reasonable time-lag between an advance in pure science and our realization of its contribution to our reservoir of new knowledge.

Research in the sectors of physics, chemistry and mathematics that gives promise of contribution to advances in telephony is carried out in the forefront of the first area. Solid-state physics, including magnetism, piezo-electricity, dielectrics and semiconductors; physical electronics; electron dynamics; acoustics; electromagnetics; mathematics; organic and physical chemistry of synthetic plastics and rubber; corrosion chemistry; physical metallurgy and fundamental mechanics is a typical but not comprehensive list of subjects.

Inspired and productive research in industry requires men of the same high quality as are required for distinguished pure research in universities. We select our young men of research from among the most able and promising of the doctorate and post-doctorate of philosophy students of our graduate schools. We have no difficulty in attracting men of this type and quality. They must be given freedoms that are equivalent to those of the research man in the university. This is indeed difficult in industry; but we are approaching that ideal. We give much attention to the maintenance of an atmosphere of freedom and an environment stimulating to scholarship and scientific research interest. It is most important to limit their work to that of research. If the scope of their interest is extended even to that of fundamental development (the next step in the chain of events from research to manufacture and use), they tend to lose contact with the forefront of their field of scientific interest. In time, a considerable fraction will lose their productivity in research.

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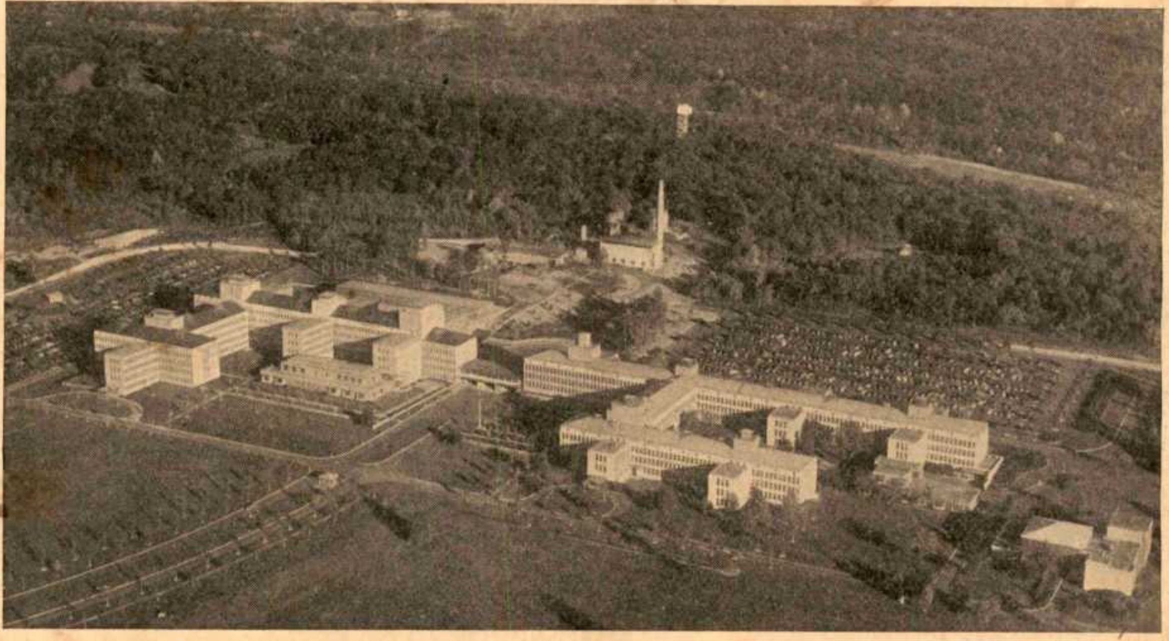
* Abstract of a paper read before the Royal Society on March 23.



Fairchild Aerial Surveys, Inc.

An aerial view of Bell Telephone Laboratories' new buildings of functional design at Murray Hill, New Jersey

To make possible the restriction of the men of science to research, we provide, through organisation and stimulated association, an intimate tie between research and fundamental development. In this way the programmes of research are taken over at a well-considered point by fundamental development, where they are extended and enlarged upon to supply the body of basic technology essential for the specific development and design of systems and facilities. While the fundamental development work is done in the best research tradition, it has a large content of the technological, and economic considerations are a factor in its programmes.

Staff members for 'fundamental development' are drawn from our research area by selecting those having technological and engineering aptitudes and interests who prefer to move into development, and by recruitment from among the most promising of the graduate students, at the doctorate and post-doctorate levels, of our schools of applied science, such as Massachusetts and California Institutes of Technology.

Approximately 30 per cent of our professional staff work in the area of research and fundamental development. This provides adequate effort to maintain close coupling between science and our technology, and supplies a sufficient volume of new knowledge to feed into the programmes of our specific systems and facilities development area. That is to say, this division of effort gives good balance in our overall programme.

The second area we call 'systems engineering'. Its major responsibility is the determination of the new specific systems and facilities development projects—their operational and economic objectives and the broad technical plan to be followed. 'Systems engineering' controls and guides the use of the new knowledge obtained from our research and fundamental development programmes in the creation of new telephone services and the improvement and lowering of cost of services already established. In determining the new development projects, 'systems engineering' considers the content of the reservoir of knowledge awaiting application and the opportunities for its use in the interest of the telephone user. The projects that are activated are those that give greatest promise for user benefit. It attempts to ensure that the technical objectives of the development projects undertaken can be realized within the framework of the new knowledge available in the reservoir and established development and engineering practices.

As the technology of communication has broadened and become more complex, the choice of the technical paths to be pursued in the instrumentation of the new technology has become increasingly difficult. No longer should the supervision of creative technology programmes make the selection of the paths by relying on its knowledge and advice from those who carry out the development operations. It is this situation that has led to the evolution of the systems engineering function as a mechanism of planning, guidance and control.

Systems engineering has intimate knowledge of our research and fundamental development work. It knows intimately the content of our new knowledge reservoir. It also has equally effective liaison with the men and their work in the specific systems and facilities development area. It has intimate knowledge of the telephone plant and its operation, and maintains close contact with the operating organisation.

It integrates the knowledge from these three areas. With this as a background it makes exhaustive studies that appraise and programme the specific development projects for new systems and facilities. Each study outlines the broad technical plan of a development, its objectives and its economic and service worth. In many of the studies it is recommended that no development be undertaken at the time. Administrative action is then taken with these studies as a guide that selects and activates the projects of our specific development programmes.

Approximately 10 per cent of our scientific and technical staff are allotted to 'systems engineering'. Its staff members must supply a proper blending of competence and background in each of the three areas with which it makes contact: research and fundamental development, specific systems and facilities development, and operations. It is therefore largely made up of men drawn from these areas who have exhibited unusual talents in analysis and the objectivity so essential to their appraisal responsibility.

We shall now turn to specific systems and facilities development, the third area of creative technology. The work here is programmed according to the patterns that systems engineering studies prescribe.

The work of this area determines the design of new systems and facilities for the operating companies. The motif of its programmes is the realization of a design that will furnish service of the prescribed quality at the lowest complete cost. The important elements of the complete cost are operation and maintenance expense and the capital charges that cover the annual costs of the investment in the new systems and facilities. The work is therefore directed at minimum cost with the best economic balance between these elements of cost. To determine the design for manufacture that will provide this cost balance, the engineers of this area work in most intimate contact with the engineers of manufacture of the Western Electric Company, the manufacturing subsidiary of the Bell System, and our systems engineering area which interprets the service requirements and the operation and maintenance cost factors.

While the work of this area is all done within the limits of the new knowledge in our reservoir and of established development and design practices, it is, even so, a most complex operation of technology, which involves close interweaving of the developer-design function, the manufacturing function, and the telephone service function. Intimate team-work between the groups involved is of paramount importance. The end-products are complete specifications and designs for manufacture and instructions for operation and maintenance.

Some 60 per cent of the members of our professional staff work in this area. They are principally graduate engineers—electrical, mechanical, chemical and metallurgical—from our technical schools and universities.

The story of Bell Telephone Laboratories would not be complete without reference to its military development programmes for the United States. During the War we turned our attention almost completely to the creative technology of instrumentation for warfare. New facilities for communications, radar, sonar, gun directors, are typical of our areas of work.

At the close of hostilities, with military preparedness becoming an important element of national policy, our Laboratories has continued in military creative technology. Approximately 20 per cent of our effort is so employed.

The philosophy of work and organisation of effort evolved in our serving an operating organisation—the Bell System—makes us uniquely suited to aid the Services, which is another operating organisation. The pattern of our activities for the Bell System—a broad programme of research and fundamental development to obtain new knowledge of value to telephone service; the scientific determination of the best applications of the new knowledge in the interest of service; and the development and design of new facilities best suited to the service—is the pattern in which we are carrying out our work in creative technology for the military.

By the mid-1930's we were painfully aware of the limitations on our effectiveness imposed by the non-functional housing of our Laboratories in New York City. A small committee made a study of housing, services and facilities, extending over three or four years, arriving at a completely new design of laboratory buildings, service arrangements and facilities that made a distinct break with the past.

The motif of the design was the maximum of functional facility with complete flexibility in room size, laboratory services and equipments. Size of rooms, their equipments and services employed can be quickly and inexpensively altered. The original unit was completed in 1941 at Murray Hill, New Jersey, some twenty miles from New York City, and was first employed in our war research and development programmes.

The effectiveness which this functional structure added to our war research and development programmes completely justified the philosophy of design. Construction on a second unit was begun immediately after the close of hostilities. We are now completing its occupancy and will have some 2,500 scientific men, engineers and their associates (40 per cent of our staff) working in these new laboratories.

The design of the Murray Hill Laboratories has attracted international attention. Some thirty-two laboratories in the United States have been constructed since the close of the War along the functional lines established by our design. We have visitors from many parts of the world studying the design pattern. While I do not know the extent to which it has been incorporated in new buildings in other countries, we know of one as far removed as India that has followed its basic principles.

THOMAS WRIGHT'S "ORIGINAL THEORY" OF THE MILKY WAY

A CELEBRATION in honour of Thomas Wright of Durham was held on June 2 in the Science Laboratories of the University of Durham. Different from most historical celebrations, its purpose was not to recall a memorable date in the life of a famous man but to direct the attention of wider circles to an astronomer much less known than he deserves to be. The "Encyclopedia Britannica" does not mention him at all, and paragraphs concerning him in biographical dictionaries are very meagre and inaccurate. Born in Byers Green, a little village near Durham City, he spent most of his life there and called himself always Thomas Wright "of Durham"; so two hundred years after the publication in 1750 of his most important book "An Original Theory or New Hypothesis of the Universe", in which he gives an explanation of the Milky Way, the University of Durham made this attempt to revive his memory.

The celebrations were introduced by Prof. H. Dingle, of University College, London. In a lecture on "Thomas Wright's Astronomical Heritage", he examined carefully all sources of information which might possibly have influenced Wright in his astronomical conceptions and especially in his interpretation of the Milky Way. He came to the conclusion that all Wright's forerunners had considered the Milky Way as one of the constellations on the celestial sphere; that since Galileo this luminous band was known to consist of many stars, and that from one author—Dr. Derham, whom Wright mentions—he might have learnt that the strange appearance of the galaxy presented an unsolved problem; but the direction in which Wright found the explanation is not foreshadowed anywhere and his publication was in the fullest sense original.

Following the first speaker, Prof. F. A. Paneth, of the University of Durham, discussed the two reasons for which Thomas Wright ought to be remembered in the history of astronomy. He was the originator of the idea of the disk-shaped universe; it occurred to him that if our sun with its planets were situated in the interior of a flat stellar system, on purely geometrical grounds we would see many more stars when looking in the direction of the plane of the disk than in any other direction. In this case there would be in Nature no crowding together of stars in the Milky Way, but this celestial circle would only be an optical effect, due to the peculiar form of the stellar system to which we belong.

Essentially the same interpretation of the Milky Way was given thirty-five years later by W. Herschel, who—without any knowledge of Thomas Wright's book—based it on the convincing results of his star-gauging in various directions of the sky. There can be no doubt that the priority of this fundamental idea belongs to Wright; but since his "Original Theory" had no direct influence on the development of modern astronomy, this historical fact alone would have not more than a limited interest for specialists. There is, however, a second, much stronger, argument for remembering Wright: his book was the spark which fired the imagination of Immanuel Kant to develop his famous theory of celestial evolution. This great scientific cosmogony would probably never have been written if Kant had not seen, by mere chance, an abstract of Wright's book in a German periodical. Wright's conception of the universe was purely geometrical, but Kant considered immediately the forces acting therein; the disk-like shape of the stellar system seemed to him proof of its rotation—a conclusion since verified—and the elliptical nebulæ he interpreted correctly as external galaxies. (Kant was the first to use the word in the plural!) The idea of cosmic evolution which is the essential part of Kant's theory follows almost logically from Wright's assumption of the flat universe.

After the two lectures, an excursion was made to a strong stone tower at Westerton, about seven miles from Durham, which for more than a century has been known to the local population as the "Westerton Folly", its original purpose being completely forgotten. Now it bears a freshly fixed tablet with the inscription:

> This Observatory Tower was erected by
> THOMAS WRIGHT
> born at Byers Green 1711, died there 1786.
> To commemorate his treatise
> THEORY OF THE UNIVERSE,
> published 1750, this tablet was placed here
> by the University of Durham, 1950.

An exhibition in the University of Durham Library of Thomas Wright's published works, of manuscripts or photostat copies of manuscripts from the British Museum, the Royal Society, the Royal Astronomical Society and the Newcastle Public Library, and of drawings and pencil sketches representing a great variety of subjects, gave visitors a good impression of the genius of this versatile and highly original man.

It is hoped that his autobiography, the manuscript of which is still extant, will be edited this year by a competent scholar; it tells a very human, and in parts touching, story of a boy whose early love for the study of mathematics and astronomy was so much opposed by his father that he ran away from home, penniless, but carrying with him the load of all those books which his father had not burned. It narrates how, against many odds, he slowly succeeded in having his works printed and getting access to the houses of the nobility as a teacher of astronomy, which in those days was a fashionable hobby with the ladies. It finishes with the description of the stately house he built in his native village and in which he died in 1786, too isolated, it seems, to have heard before his end of Herschel's fundamental paper presented to the Royal Society a year earlier, which proved the correctness of Wright's idea about the nature of the Milky Way.

F. A. Paneth

INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION

EIGHTH INTERNATIONAL CONFERENCE

THE Eighth International Conference of the International Committee for Bird Preservation, the first world conference to be held since the Second World War, took place in Uppsala during June 8–10, and was attended by representatives of the following national sections: Austria, Belgium, Canada, Denmark, France, Germany, Great Britain, Greece, Hungary, Iceland, Italy, Japan, Netherlands, Spain, Sweden, Switzerland and the United States; Luxembourg, which is not yet a member of the International Committee, sent an observer.

The following elections were made: *President*, Jean Delacour (United States); *Vice-Presidents*, Leon Lippens (Belgium) and Colonel Casales (Argentine); *Secretaries*, Miss Phyllis Barclay-Smith (Great Britain), Richard Pough (United States) and Georges Olivier (France). Dr. Bøje Benzon (Denmark) was elected chairman, and Prof. A. Ghigi (Italy) vice-chairman, of the European Continental Section.

The business of the Conference opened by a report of the international sub-committee on conditions of birds transported by air, which set forth measures considered necessary to ensure the proper care of these birds in transit. Prof. Ghigi (Italy) directed attention to the harmful effects of delays due to customs formalities in dealing with birds being transported by air, and it was agreed at the meeting that the governments concerned should be approached, with the request that measures should be taken to enable customs officials to give priority to live birds. A full report of the administration and research being carried out by the recently formed International Wildfowl Research Institute at Tring, England, was submitted to the meeting on behalf of Dr. Edward Hindle, the honorary director, giving details of the work being carried out on the summer migration of the sheld-duck (see *Nature*, December 31, 1949, p. 1122), with special reference to food and food preferences, mortality, correlation of ringing recoveries, systematic studies, etc. This report was followed by statements on the activities of wildfowl inquiry committees of various national sections, the results of which will be correlated by the Institute at Tring.

Much discussion took place regarding the pollution of the sea and of inland waters, and its consequent injurious effect on bird and marine life. Some delegates were of the opinion that the matter should be dealt with separately, as the causes are from different origins; but eventually it was decided that the matter should be investigated by one international sub-committee, a further one being set up at a later date to deal specifically with inland pollution should this prove necessary. The need for urgent international action to prevent the discharge of waste oil on the sea was emphasized, and the efforts of the League of Nations in 1926 to bring about an international convention on the matter was referred to. The sub-committee set up consists of representatives of Belgium, Denmark, Great Britain, the Netherlands, Sweden and the United States.

The danger to bird life of the improper use of insecticides was referred to by Prof. Ghigi, who directed attention to the great destruction caused to both animal and plant life in Sardinia where DDT had been sprayed from aeroplanes with the most disastrous results. This view was supported by many other national sections, and as a result the following resolution was passed.

"In view of the damage to bird life caused by the use of strong modern insecticides, either by the use of a dose which may prove toxic to birds or by the creation of a famine among insect-eating birds whose food is indiscriminately destroyed, and in view of the recommendations in the same sense adopted at the International Technical Conference for the Protection of Nature held at Lake Success in August 1949—

"The 8th International Conference of the International Committee for Bird Preservation resolves to invite responsible Governments to examine urgently the possibilities of making available to agricultural authorities and to the manufacturers and distributors of insecticides in their countries the results of the scientific researches already undertaken successfully (notably in the U.S.A.) regarding the effects upon bird life and upon animal populations generally of the use of different doses (per acre or per hectare) of modern insecticides.

"The Conference also invites Governments to investigate means of persuading farmers and other users of insecticides not to exceed the doses recommended by the manufacturers, which should be scientifically verified. The Conference hopes that these recommendations will be supported by those concerned with the dangers caused by excessive or incorrect use of pesticides to consumers of agricultural products and to workers handling them and applying them to crops."

The German representatives urged the necessity for further protection of migratory birds and in particular the curtailing of shooting in the spring, and this view was supported by members of many other European countries. The Netherlands delegates, on their part, directed attention to the need for better protection of waders, and reported that in their country many species of these birds are given complete protection. A proposal put forward by the Swedish National Section, for the establishment of a series of reserves throughout Europe on known migration routes on the same system as the 'flyway' refuges in the United States and Canada, was welcomed; and the high value of such a system generally was acknowledged, although it was realized that the difficulties of creating such a series of reserves in Europe would be far greater than in America, on account of the number of different countries involved. It was agreed that the protection of migratory birds and waders and the establishment of reserves are interdependent, and a subcommittee consisting of representatives of Belgium, France, Denmark, Germany, Great Britain, Greece, Italy, Netherlands, Spain, Sweden and Switzerland was set up to deal with this subject.

The Conference considered the drawing up of a list of species of birds threatened with extinction for special international measures of protection, and the list which was prepared at the International Technical Conference on the Protection of Nature, held at Lake Success in August 1949, was taken as a basis. The urgent necessity for conserving specialized island fauna was pressed, and a subcommittee, on which museum workers were largely represented, was set up to work on this subject in conjunction with the International Union for the Protection of Nature. The proposed exploitation of eggs, for use in the processing of leather, of certain birds inhabiting islands in the Antarctic was reported, and as a result the following resolution was passed.

"The I.C.B.P. having learned of the proposal to develop an industry in the eggs of sea-birds nesting on certain islands in the Antarctic under French rule, Amsterdam, Kerguelen, etc., protests against the realisation of this proposal which may result in the extinction of several species and subspecies peculiar to those islands, especially Albatrosses, Petrels, and Penguins.

"The small area of these islands and the difficulty of effective supervision constitutes a serious danger for the colonies of birds. The Committee therefore draws the attention of the French Government to the international scientific importance of this matter and to the necessity for the strict preservation of this island fauna such as was carried out in 1908 by the New Zealand Government.

"It expresses the view that severe measures should be taken to prohibit any temporary or permanent use of the eggs of these birds for industrial purposes and in any event to prohibit the import into France or any other territory of the products eventuating from any such industry."

A long discussion on the situation of birds which are a menace to other species revealed that some, which on first consideration may appear to be such a menace, may in fact play an important part in their natural selection. The herring gull, carrion crow and magpie were particularly considered in view of the great increase of these species in Europe. A subcommittee was set up to investigate the populations of gulls in countries bordering on the North Sea, and was made up of representatives from Denmark, Great Britain, Germany and the Netherlands; but the problem of crows and magpies, which only need control in certain areas, was left to the countries concerned.

The revival of the fashion of wearing plumes of birds of paradise and egrets in ladies' hats was discussed, and national sections reported on the legislation on this matter existing in their various countries. Attention was directed to a new development in the use of bird skins for decorative purposes, and it was agreed that this situation should be closely watched.

At the close of the meeting a report was read by Mr. Hoyes Lloyd (Canada) of the activities of the Pan-American Section, and national sections tabled reports on the situation regarding bird preservation in their respective countries; these will be published in the next Bulletin of the International Committee for Bird Preservation.

DUNLOP RESEARCH CENTRE, BIRMINGHAM

THE Dunlop Research Centre, at Fort Dunlop, Birmingham, was officially opened by Sir Lawrence Bragg on June 7. The ceremony was preceded by a luncheon in the Dunlop Hall, at which Sir Clive Baillieu, chairman of the company, presided and which was attended by the Lord Mayor of Birmingham (Alderman A. Paddon Smith), representatives of government departments, universities, research associations and a large body of the Press.

Speaking at the luncheon, Sir Clive Baillieu emphasized the importance of the steps taken to reduce the time lag between the discovery of new research knowledge and its application on a production scale. Sir Lawrence Bragg said that it is no easy matter to forge a link between the universities and industry as the outlooks are so different. The pure scientist, he continued, knows that planning means the death of scientific advance, and, when knowledge for its own sake is the goal, the rate of progress is greatly increased. Pure science is the reconnaissance on behalf of the occupying army of technology, and the pure scientist should so simplify his knowledge as to make it attainable by all who wish for it. Sir Lawrence condemned misleading statements about the relationship between science and industry, and went on to say that the developments in industry are not made by pure scientists, but the latter often supply new lines of thought which make the ideas arising in industry realizable. Science is a superstructure, not a foundation of industrial development; it is something which multiplies industrial effort. The human factor in any research organisation is the major one, and hence 'motivation' of the staff is very important. Sir Lawrence concluded by saying that the success or failure of the Dunlop Research Centre would depend on the ability to develop people who wanted to see round the corner and into the future.

After luncheon, the party moved to the Research Centre, where the symbolic opening took the form of cutting a cord stretched across the main doors. The cord was appropriately in the form of a greatly enlarged rayon tyre cord in the Company's colours of black and gold, the two materials being associated with Dunlop patents. The guests then made an inspection of the Centre, the type of work in hand being illustrated by sixty-seven exhibits and demonstrations.

The need has been long felt for a central organisation to serve the world group of Dunlop companies in respect of research and long-term development. The project for such a centre began to take shape during the Second World War, and the original intention was to have an entirely new group of buildings. However, conditions following the War made this impracticable, and an alternative scheme was sought. Fortunately, part of a large aircraft factory adjacent to Fort Dunlop became available, and suitable buildings were taken over. The two-story administration building (area 129,000 sq. ft.) has been almost completely reconstructed to form the research building, an emergency power-house adapted (with considerable extension) as a pilot plant building (total area, 18,500 sq. ft.) and an entirely new engineering services building (2,400 sq. ft.) erected between the two main structures. There are three temporary buildings (4,250 sq. ft.) also in use, so that the total working area is more than 154,000 sq. ft. All the plants are spaced well apart on a site totalling nearly eight acres. The Research Centre is situated about six miles out of Birmingham, on the north-east side. It is excellently situated with respect to main roads, having easy access to all parts of Great Britain without passing through Birmingham.

Building and reconstruction began in the spring of 1947, and steadily went forward in the face of post-war controls, material shortages and other difficulties. The work was carried through by contractors under the supervision of the Company's architects, and most of the engineering work was done by the Company. The buildings are modern ones, in steel and brick construction, with reinforced concrete floors. The laboratories of the research building are separated on the upper floor by steel screening, and on the lower floor by brick walls. Most of the heavy plant is on the lower floor. The colour scheme is cheerful, being predominantly cream for both the walls and the plastic tiling. Each floor has its own ventilation system, that for the lower floor, because of there being a number of enclosed rooms, also having extract ducting. For the special needs of the textile- and rubber-testing laboratories, an entirely separate air-conditioning plant provides constant temperature and humidity conditions. Fluorescent lighting giving a minimum of 25 lumens is installed, and there is a low-voltage incandescent system coming into operation automatically in case of mains failure. The underground subway, carrying the vast network of engineering services to the various laboratories, is a noteworthy though inconspicuous feature.

Due to the wide variety of the Company's activities and the unusual properties of rubber and rubber-like materials, there are some fifty different laboratories (excluding workshops), separated on a functional basis. There is a library where, in addition to reference works, some hundred and fifty current technical periodicals are always available. Well-equipped dining rooms have been provided, as well as the usual conference rooms and stores. The lecture theatre, seating a hundred and sixty people, is fully equipped for film projection. Including clerical, administrative and auxiliary-service workers, the total technical staff of the Centre is now 276. Of these, a hundred are graduates or hold diplomas of graduate status, eighteen different universities being represented.

The work of the Centre is grouped roughly into research, under Mr. F. G. W. King, and development, headed by Mr. E. A. Murphy, although the two groups work in close co-operation. The research administration comes under Dr. W. C. Davey. The main research activities are classed under the headings of chemical, compounding, physical and textile. Chemical research work (under Dr. W. C. Davey) includes the preparation and fundamental study of high-polymers, chemical derivatives of rubber, and studies relating to rubber latex. The kinetics of the major manufacturing operations are also studied. For such work, the equipment available includes an infra-red absorption spectrometer, Spekker absorptiometer, and an ultra-violet spectrometer; also there is a laboratory for use of radioactive isotopes, particularly carbon-14 and sulphur-35, as tracers. In the analytical section, special attention is given to modern methods such as micro-analysis, polarography, and paper and column chromatography.

The basic compounding processes for rubber are concerned with vulcanization, reduction of oxidation, and reinforcement. The study of vulcanization and oxidation is partly the province of high-polymer chemistry, but a necessary complement is work on the mechanical properties of the vulcanizates. Reinforcement results from the action of the surface forces between the particles of such substances as finely divided carbon blacks and the rubber matrix. Compounding research (Dr. D. Parkinson) into the nature and distribution of these forces includes studies of the physics of the disperse system and direct examination with the electron microscope of the particles of reinforcing materials.

Included in the wide range of physical research work (Mr. E. F. Powell) are studies of the rheological properties of rubber, the measurement of electrostatic surface charges and voltages, electrically conducting rubber, and photo-electric colour measurement. The application of electronic devices to process problems, testing of products for use under arctic conditions, design and use of instruments for study of vehicle and tyre performance, non-destructive testing of products by ultrasonic transmission measurement, and the use of radioactive isotopes for film gauging are examples of directly practical work on hand. Textiles are of major importance in the rubber industry, and investigations are going forward with the many new textile fibres now available (Mr. J. Anderson and Dr. J. W. Illingworth). Extensive research and testing equipment is available, and small-scale rubber-textile processing plant has been installed. There are also other groups dealing with research into design of products, particularly tyres (Mr. W. E. Hardeman and Mr. L. J. Lambourn), and into methods of accurately assessing performance in service (Mr. E. S. Tompkins).

Development work, concerned with transforming research projects into practical factory processes, covers a very wide field. It is conveniently divided into colloid and chemical (Mr. E. W. Madge) and physical work (Mr. H. F. L. Jenkins). The former group gives special attention to rubber latex projects, to the application of new synthetic materials, and to the study of new products and the methods for manufacturing them. This group is also directly linked with the newly formed Dunlop Research Centre in Malaya. Together, they carry out and co-ordinate most of the fundamental and control work relating to the Company's latex production. The physics group is concerned with the use of rubber and rubber-like materials in industrial engineering, such as shock absorbers, suspension systems and anti-vibration devices. It also studies the testing of products under special conditions of service. Both these groups have extensive laboratories, but they are also the main users of the pilot plant building. While part of the plant installed there is of a permanent nature, the layout is planned to ensure the utmost flexibility to permit investigations of a wide variety of ever-changing problems.

Development workshops for the direct fabrication and modification of prototype plant are provided in both the pilot plant and the main building. There are several sections for supplementing and giving service to the research and development staff. Among these may be mentioned the information, instrument, photographic and reproduction, and industrial design sections. The information section, closely linked with the library, organises an internal abstract service. It also supplies technical information on any subject, either from its own or outside sources. The special prototype apparatus required by the technical personnel is provided by the instrument section. In addition to precision machine tools for general work, there is a Pultra micro lathe carrying many accessories with which the finer clockwork type of jobs are executed. The photographic section is well equipped for both still- and motion-picture techniques. It has various systems for copying documents and drawings, and provides a complete service for preparation of reports. Finally, there is the industrial design section, the purpose of which is to study and advise on the appearance of new products in relation to their functional requirements. W. C. Davey

OBITUARIES

Sir James Henderson

Sir James Blacklock Henderson, who died on April 7 at Blackheath at the age of seventy-nine, was the eldest son of the late James Henderson, headmaster of Whitehill Higher Grade School, Glasgow, and it was in his father's school that he received his early education. Following this he went to Allan Glen's before taking up his studies at the University of Glasgow, where he graduated in 1892. He was then awarded an 1851 Exhibition science research scholarship, and spent the first year on research work under Lord Kelvin and the second year in Berlin studying under Helmholtz, Planck and others. In 1894 he was appointed lecturer in physics at Leeds under Prof. Stroud, for whom he had an intense admiration. On leaving Leeds in 1898 he became head of the scientific department of Messrs. Barr and Stroud, returning to the University of Glasgow in 1901 as lecturer on electrical engineering under Prof. Archibald Barr.

In 1905 he was appointed professor of applied mechanics at the Royal Naval College, Greenwich, in succession to Prof. Dunkerley. During his tenure of that chair he applied himself to Service requirements and soon became interested in the wide variety of problems that confront the naval officer. Among his published papers on these subjects are "The Flight of a Rifled Projectile in Air", and a "Contribution to the Thermodynamic Theory of Explosions" jointly with Prof. H. R. Hasse.

Sir James was a prolific inventor and patentee. He always took a lively interest in the application of the gyro to problems of stabilization at sea, and his researches in this subject were commenced well before the First World War. One of the fruits of this work was the introduction of the Henderson firing gear into the Allied navies on an extended scale during the First World War, for which he received the Order of the Sacred Treasure of Japan (2nd Class).

In the years following 1918, Henderson continued his work on gyro equipment, including gyro compasses. In 1920 he was appointed advisor on gyroscopic equipment to the Admiralty, relinquishing the chair at Greenwich to Bernard Parker Haigh. On that change of office he received the honour of knighthood. The advent of the Second World War saw him once again in the front ranks of gyro development.

His interests were, however, not limited to gyros. He contributed papers to many institutions, including the Institute of Naval Architects, on problems of interest to the naval architect, and to the Institution of Mechanical Engineers on steam flow. One of his earliest papers, communicated by Lord Kelvin to the *Proceedings of the Royal Society* in 1893, related to the effects of mechanical stress on electrical resistance, a subject of interest to-day in the design of resistance strain gauges.

Henderson was a teacher as well as a research worker, and his students will always remember him as bringing to Greenwich the Stroud system of units. The origin of the system is obscure, although in a paper to the British Association 1923, he gives credit to Prof. William Stroud, of the University of Leeds. Henderson delighted to introduce his students and colleagues to the virtues of a system which has now become known throughout the Navy, and the pound weight written with a capital (Lb.) and the pound mass written with lower case (lb.) are now familiar not only to all those who knew Henderson but to those also who have benefited by the foundation laid by him at Greenwich.

Sir James received the honorary degree of doctor of laws from the University of Glasgow in June 1932 on the occasion when he delivered the Commemoration Day Oration on W. J. Macquorn Rankine. He married Miss Annie Margaret Henderson, daughter of the late Joseph Henderson, of Esp Hill, Haydon Bridge, Northumberland, who died some twelve months ago. F. W. THORNE

WE regret to announce the following deaths :

Mr. A. Abbott, C.B.E., formerly H.M. chief inspector of technical schools, Ministry of Education, on June 19, aged seventy-eight.

Admiral Sir Mostyn Field, K.C.B., F.R.S., during 1904–9 hydrographer of the Navy, on July 3, aged ninety-five.

Mr. V. K. Maitland, C.S.I., chief forestry adviser to the Persian Government and formerly chief conservator of forests, Central Provinces, India, aged fifty-two.

NEWS and VIEWS

Physics at Birmingham :
Prof. M. L. E. Oliphant, F.R.S.

PROF. M. L. E. Oliphant, since 1937 Poynting professor of physics in the University of Birmingham, where he has played a large part in the development of the University's academic structure, leaves this month to direct the School of Physical Sciences at the Australian National University, Canberra. Oliphant went to Birmingham from the Cavendish Laboratory, where his early work with positive ions had demonstrated his remarkable experimental skill, and his later studies of nuclear disintegrations with high-voltage apparatus had shown his aptitude for building and using the large-scale apparatus that was at that time becoming prominent in nuclear physics. The timely generosity of Lord Nuffield enabled Oliphant to build a new research laboratory at Birmingham and to start the construction of a 60-in. cyclotron; but the approach of war turned his energies to centimetre-wave radar, and his laboratory quickly made the outstanding contribution of the cavity magnetron. In 1943 he and several of his colleagues left Birmingham for the United States of America to help in the electromagnetic separation of uranium isotopes. This was a task for which Oliphant's experience and qualities were ideal ; in his Cambridge days he had taken the leading part in the electromagnetic separation of lithium isotopes for studies of nuclear disintegration.

Prof. Oliphant was, however, already looking ahead to post-war research, and his was the first of three independent conceptions of the application of frequency-modulation to the cyclotron principle. By the end of the War his plans had crystallized into the proton synchrotron, designed for an energy of more than 1,000 MeV., now under construction in the Nuffield Laboratory at Birmingham. He has created not only equipment of the most bold and advanced design, but also a large and active school of physics by no means limited to nuclear research. Oliphant's return to the land of his birth after twenty-three years is a loss to British university and scientific life that is fortunately lessened by his strong sense of Commonwealth unity, which, combined with more personal ties, will certainly keep him in close and frequent contact with British science.

Physics at the University College of North Staffordshire :
Dr. F. A. Vick, O.B.E.

DR. F. A. VICK, whose appointment to the chair of physics in the University College of North Staffordshire has already been announced, graduated at Birmingham in 1932 and carried out his first research there under Dr. Martin Johnson on adsorption of gases on solids. In 1936 he was appointed to the staff of University College, London, where he worked on the electrical properties of thin adsorbed layers until 1939, when he was seconded to the Ministry of Supply. During the War he served in the Ministry as assistant director of scientific research in charge of general physics and received the O.B.E. in recognition of his work. In 1944 he accepted an invitation to join the physics staff at the University of Manchester as lecturer and later senior lecturer. In his short period at Manchester, Dr. Vick has made a conspicuous contribution to the activity of the University and to its relations with industrial and professional bodies. He has taken a large share in University administration, served as a member of the board of the Institute of Physics, as chairman of the Manchester Branch of the Institute, and as chairman of the Manchester Federation of Scientific Societies. He has also been a popular president of the Manchester branch of the Association of University Teachers. Under his direction a most active school of research on the fundamental problems of thermionic emission has developed in Manchester, which will form the nucleus of research at his new post. In leaving Manchester, Dr. Vick carries with him the good wishes of all his colleagues in the physical laboratories and of those with whom his wider interests have brought him into contact.

Engineering at University College, Cardiff:
Prof. W. N. Thomas, C.B.E.

Prof. W. Norman Thomas, who retires in September, has occupied the chair of engineering at University College, Cardiff, for twenty-two years and has twice been dean of the Faculty of Science. During this period the Department of Engineering has developed very considerably, and several new laboratories have been equipped. It was due to his interest and initiative that degree courses in building were instituted at Cardiff, and the University of Wales was the first to offer a degree in this subject. He is well known as the author of a standard text-book on "Surveying" and has published many papers, including those on the effect of surface finish on the fatigue strength of steel, phenomena connected with the freezing of building materials, etc.

When the Civil Defence Research Committee was formed in 1939, Prof. Thomas was appointed a member; immediately war was declared, he was seconded from Cardiff as a scientific adviser and later became deputy chief adviser in the Research and Experiments Department of the Ministry of Home Security. In connexion with this work he was flown to Moscow in 1941; and, after the atomic bombs had been dropped on Hiroshima and Nagasaki, he was sent to Japan with the honorary rank of group-captain in the Royal Air Force and as the leader of a party to report upon the effects. In recognition of his war work, he was awarded the C.B.E. in 1946 and received also the American Medal of Freedom. Prof. Thomas has wide interests and has served on many committees, including the Building Research Board of the Department of Scientific and Industrial Research, the Scientific Advisory Council of the Ministry of Works, the Architectural Science Board of the Royal Institute of British Architects, etc. On several occasions Prof. Thomas was president of the University College Engineering Society. He was at all times readily accessible to students, by whom he was regarded both as professor and friend, and his retirement will be regretted by staff and students alike.

Dr. C. Gurney

Dr. C. Gurney has been appointed to succeed Prof. Thomas at Cardiff. After taking an engineering degree at Cardiff in 1932, Dr. Gurney spent some years in the aircraft industry, and in 1937 joined the scientific staff of the Royal Aircraft Establishment, where he was engaged on research into aircraft structures and into the properties of materials. In 1948 he was appointed university lecturer in engineering at Cambridge. Dr. Gurney is the author of scientific papers on a wide range of subjects, including theory of elasticity, thermodynamics and the properties of materials. Particularly noteworthy are his papers in collaboration with Mr. S. Pearson on the mechanical properties of glass and his recent papers on surface forces in liquids and solids. Dr. Gurney possesses a keen scientific insight combined with the practical ability of the engineer. He joins University College, Cardiff, at the beginning of a period of great expansion of facilities and amenities, and it is expected that he will take a prominent part in the development of education in the applied sciences in South Wales.

Protection of Laboratory Animals

A first draft for a model "Act for the Protection of Laboratory Animals" has been circulated by the Universities' Federation for Animal Welfare for the purpose of eliciting constructive criticism and enabling a revised draft to be eventually offered to foreign inquirers who may wish to profit by British experience in the regulation of experiments on animals. The proposals are based on British practice; but they differ from it in important respects. Thus, the Act would apply not only to animals under experiment but also to 'biomedical manufactures', that is, the manufacture of sera, vaccines and the like *in vivo*, and to the management and supply of laboratory animals. Unpopular species would be protected equally with popular species. The Act would permit the use of stray animals subject to safeguards, and also operations, carried out under full anæsthesia without recovery, for the purpose of acquiring manipulative skill. On the other hand, it would not permit any experiment which involves substantial suffering of more than moderate duration or severe suffering of more than brief duration, or extreme suffering. The obvious difficulties of definition which these expressions involve are left to be solved by discretion, analogy and precedent, with the guidance of examples given in a schedule which is obviously intended only as a basis for discussion. In accordance with British practice as disclosed in the annual reports of the Home Office, no operation (defined as "the infliction of a trauma more serious than that caused by skilful subcutaneous venesection or the insertion of a sharp hypodermic needle") would be permitted without anæsthesia. A clause of the draft Act is devoted to an elaboration of the meaning of anæsthesia.

The day-to-day administration of the Act would be directed by a scientific, veterinary and humanitarian board of control having inspectors under it. Licences would be granted by the board after inquiry into the applicants' scientific ability and general character, and would be graded in accordance with the severity of the procedures authorized; a licence would not cover operations with or without recovery, electric stimulation, or demonstrations to students, unless a specific clause to that effect were added. There would be a subordinate grade of licences for laboratory technicians, who would be permitted to carry out prescribed procedures under the experimenters to whom they were attached. Discipline would be exercised on behalf of the Minister of the Interior by the board of control, and there would be a right of appeal to a tribunal. The draft, which runs to ten pages of typed foolscap, can be obtained from the Universities' Federation for Animal Welfare, 284 Regent's Park Road, Finchley, London, N.3, which would welcome constructive criticism.

Conference in New Zealand of the Universities of the British Commonwealth

At the sixth quinquennial Congress of Universities of the Commonwealth, which was attended by 350 delegates of a hundred university institutions at Oxford in 1948, it was decided that in addition to such conferences there should be held each year a small meeting of representative heads of universities or senior academic officers from each part of the British Commonwealth to discuss matters of academic policy on which closer consultation is necessary than can be given in large congresses held at long intervals.

It was agreed that these meetings should take place in different parts of the Commonwealth, and this policy was inaugurated in July 1949 with a conference at Halifax, Nova Scotia, arranged in conjunction with the annual meeting of the National Conference of Canadian Universities. The second such conference is being held, with the generous support of the Nuffield Foundation, in New Zealand this year, when eighteen senior university executive heads drawn from all Commonwealth countries will attend. It opens at Wairakei on July 31 with a meeting of the executive council of the Association of Universities of the British Commonwealth (which, in conjunction with the authorities of the University of New Zealand, is convening the conference). Sessions will also take place at Auckland, Dunedin, Christchurch and Wellington, where the conference will end on August 21. The opportunity is being taken by the delegates to visit the various university centres in New Zealand, and, so far as possible, those in Australia also. The conference will be presided over by Prof. I. A. Gordon, vice-chancellor of the University of New Zealand, who is the chairman for this year of the Association of Universities of the British Commonwealth. The secretarial arrangements are in the hands of Dr. J. F. Foster, secretary of the Association of Universities of the British Commonwealth, and of Mr. I. F. McKenzie, registrar of the University of New Zealand.

International Committee for the Study of Clays

An International Committee for the Study of Clays (Comité International pour l'Étude des Argiles) has been formed with the aim of grouping specialists in the study of clays, from whatever angle, in different countries. In particular the Committee intends to collect a full documentation on the results and methods of clay studies; to promote contacts between specialists in such studies; to organise conferences from time to time, in which questions relevant to clay studies will be discussed, aiding specialists to compare their results; and to unify their methods of description. The Committee will help to bring about exchanges of reference samples between research workers, and will try to define the terminology and methods used in the scientific study of clay. Several national committees for clay studies have already been formed, notably in Belgium, France, Great Britain and Sweden. The International Committee consists of a maximum of two members per country. An executive sub-committee was recently appointed in London made up of four persons: *Chairman*, S. Henin (France); *Secretary*, M. Lepingle (Belgium); *Members*, R. E. Grim (United States), and D. M. C. MacEwan (Great Britain). A meeting of the full Committee is to be held in Amsterdam during the forthcoming International Congress of Soil Science (July 24–August 1), when plans for its future activities will be discussed. Those who have suggestions to make regarding the work of the Committee should write, as early as possible, to one of the British representatives: Dr. D. M. C. MacEwan, of Rothamsted Experimental Station, Harpenden, Herts, or Dr. G. W. Brindley, of the Department of Physics, University of Leeds.

Distribution of Classes of Students in British Universities

An interesting analysis has been made by Political and Economic Planning in its latest Broadsheet (No. 310) of the geographical, educational and social origins of a group of full-time students entering six university institutions in England and Wales for the first time in the academic year 1947–48. Except in respect of age, the differences between the ex-Service men and those leaving school are not important; but a distinction must first be made between those students whose homes are in Great Britain and those from overseas. Overseas students mainly tend to enter the old institutions of international repute, two out of three Commonwealth and five of every nine foreign students entering Oxford, Cambridge, London and Edinburgh; the latter were mainly men and had mostly already completed a degree course in their own country. Except for Oxford and Cambridge, most British universities draw their students mainly from their own locality. At an ancient university sampled under the name 'Camford', a college of the University of London and a university college, a noticeable proportion of students come from other universities; but, whereas at 'Camford' nearly half the total entry of men students came from fee-charging schools, and from a relatively small number of schools, elsewhere the proportion of students from fee-charging schools was small, and few local authority schools sent more than one or two pupils to any one institution. The student from a local-authority school is, however, coming to occupy a more important place in the older universities, and the modern universities are beginning to receive a substantial number of entrants from fee-charging schools, ranging from 50 to 87 per cent in the faculties of arts and of science, while in medicine and law the entrants from fee-charging schools are relatively more important. As regards social origins, the children of manual workers are under-represented at all the British universities, but particularly at Oxford and Cambridge. Women students tend to come from higher social groups than their male colleagues, and social classes are represented more evenly at the University of Wales and the Scottish universities than at the English universities, Oxford and Cambridge being still largely the preserve of the professional classes.

Supply of Very Thin Copper Foil

Limited supplies of very thin copper foil from a pilot plant are now available from N. M. Rothschild and Sons, of the Royal Mint Refinery, 19 Royal Mint Street, London, E.1. The foil can be supplied in sheets up to 30 in. by 5 in. in area and down to 0·00012 in. in thickness. At a later stage, when the full-scale plant is in production, it is anticipated that lengths of several hundred feet will be available. The chemical composition of the copper foil conforms to electrolytic standard, and its electrical conductivity is 95 per cent of the International Annealed Copper Standard minimum. The foil, which has one side polished, can be supplied with platings of various metals on one or both sides.

National Research Council of Canada: Merck Fellowships

The National Research Council of Canada has awarded the following five Merck postdoctoral fellowships in the natural sciences for the year 1950–51: Dr. D. A. I. Goring, of the Department of Physical Chemistry, McGill University, for the continuation of his research in colloid science under Prof. F. J. W. Roughton, at the University of

Cambridge; Dr. J. Gross, of McGill University, for work at the National Institute of Medical Research, London, on the mechanism of concentration of iodine in the thyroid gland; Dr. H. B. Stewart, of Toronto Western Hospital, for research at the School of Biochemistry, University of Cambridge; Dr. W. L. Holmes, of the University of Toronto, and at present a research assistant in the Department of Animal Nutrition, Ontario Agricultural College, Guelph, for work at the Department of Pharmacology, Western Reserve University, Cleveland, Ohio; Dr. L. Ouellet, of Laval University, for research at the Catholic University of America, Washington, D.C. The value of these fellowships is 3,600–4,500 dollars, which includes travel allowance and a grant of 500 dollars to the institution at which it is proposed to study. Funds for the fellowships are provided by Merck and Company, Ltd.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: J. N. Clothier (senior agricultural officer, Northern Rhodesia), chief conservation officer, Northern Rhodesia; M. Halcrow (deputy director of agriculture (designate), Nyasaland), deputy director of agriculture, Northern Rhodesia; R. E. T. Hobbs (assistant director of agriculture (field services) (designate), Kenya), deputy director of agriculture, Kenya; K. R. S. Morris (entomologist, Gold Coast), director, Tsetse Control, Gold Coast; M. Milliken, agricultural economist, Northern Rhodesia; J. E. F. Douay, assistant conservator of forests, Sierra Leone; L. M. Bear, geologist, Kenya; R. G. Seal, geologist, British Guiana; A. F. S. Ohman, senior veterinary officer, Fiji; H. Bassett, mineralogist/chemist, Lands and Mines Department, Tanganyika; R. Kennard, agricultural survey officer, Gold Coast; B. R. Nettleton, assistant meteorological officer, Federation of Malaya; J. Weir, lecturer in agricultural engineering, Egerton School of Agriculture, Kenya; K. K. Zwilling, fish farmer, Nigeria.

Metals in the Service of Mankind

A SPECIAL exhibition, "Metals in the Service of Mankind", is being held at the Science Museum during July 7–September 30. The exhibition has been organised by the Institute of Metallurgists in conjunction with the Science Museum, the major research and development associations and firms working in highly specialized metallurgical fields. An introductory section includes some of the tools used by early man in the times when only such materials as wood, stone and bone were available. Further exhibits illustrate the period when bronze came into use; the artistic talents of the early metal workers are also emphasized. Modern practice in the extraction and refining of the common metals is fully illustrated, and some of the varied uses of such metals as iron and steel, aluminium, copper, tin, nickel, magnesium, cobalt and cadmium are shown by means of samples, models and finished products. Processes dealing with the after-treatment of metals such as electro-deposition, welding, surface finishing and powder metallurgy are included, as well as an exhibit dealing with magnets and their uses. A metallurgical laboratory and a metal testing section illustrate the various tests to which metals are subjected. The rarer metals, several of which are only just coming into production, are also shown.

Announcements

AT a special meeting of the Section of Science of the Royal Netherlands Academy of Sciences on June 24, the Bakhuis Roozeboom Medal was presented to Dr. W. Hume-Rothery, lecturer in metallurgical chemistry in the University of Oxford. This Medal is awarded once in every four or five years for fundamental work in the field of phase-theory. It was awarded for the first time in 1916 to Prof. Schreinemakers, and since then to Tammann, Van Laar, Bridgman and Day. The meeting, presided over by Prof. A. J. Kluyver, was attended by representatives of the Dutch Minister of Education, the British Ambassador in the Netherlands, the governor of the Province of North-Holland, the burgomaster of Amsterdam, many Dutch men of science and members of the Academy and relations of the late Prof. Bakhuis Roozeboom.

ON the occasion of the celebration of Foundation Day of the University of London on November 24, honorary degrees will be conferred on the following, among others: D.Sc. on Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell; LL.D. on Sir Hector Hetherington, vice-chancellor and principal of the University of Glasgow.

THE following appointments in the University of Sheffield have recently been announced: Dr. F. J. G. Ebling, lecturer in zoology; Dr. R. T. Ackroyd, lecturer in electrical engineering; and Dr. H. D. Turner, staff tutor in science in the Department of Extramural Studies.

HERBERT REICHNER (34 East 62nd Street, New York, 21) has issued a List (No. 14) of Reference Books and Bibliographies, containing some 1,463 entries, arranged alphabetically by subject and author, relating to astronomy, biography, chemistry, botany, geology, medicine, palæography, philosophy and printing, as well as to the fine and graphic arts, literature, music, etc.; some *incunabula* and manuscripts are also included.

THE Robert Roesler de Villiers Foundation, Inc., of 417 Park Avenue, New York, 22, is offering a prize of 500 dollars (or in special circumstances 1,000 dollars) for the most significant contribution to the knowledge of the nature, causes, origin, treatment and cure of acute leukæmia and allied conditions, published during January 1, 1950–October 20, 1951. The prize has been instituted in memory of Robert Roesler de Villiers, who died of acute leukæmia at the age of 16½ years. Further particulars may be obtained from the Foundation itself, from Dr. Sven Moeschlin, Kantonsspital, Zurich, Switzerland, or from Dr. S. Haberman, 3301 Junius Street, Dallas, Texas.

APPLICATIONS are invited from university graduates and certified teachers, less than thirty-six years of age and with qualifications in mathematics, science (physics, chemistry or metallurgy) or engineering, for commissions of three to five years service in the Instructor Branch, Royal Navy. Instructors serve both ashore and afloat, and their duties include technical instruction and general education. Officers with suitable qualifications may also be trained and appointed for full- or part-time meteorological and weather-forecasting duties. Further details may be obtained from the Director (P), Education Department, Admiralty, London, S.W.1.

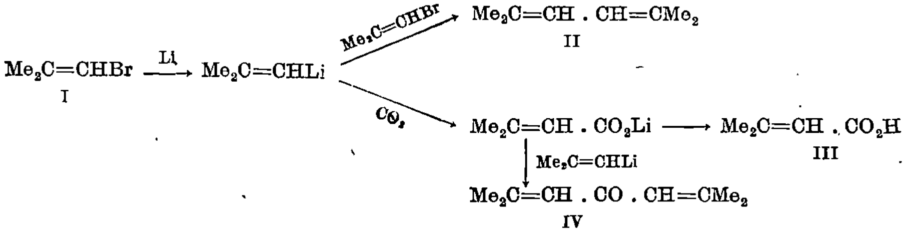
A NEW APPROACH TO THE SYNTHESIS OF ETHYLENIC COMPOUNDS

By DR. E. A. BRAUDE, J. A. COLES and DR. C. J. TIMMONS
Organic Chemistry Department, Imperial College of Science and Technology, London, S.W.7

DURING the past three years, a new method for the synthesis of unsaturated compounds, particularly those containing one or more ethylenic groups adjacent to a carbon atom carrying another functional substituent, has been developed in these laboratories. The method depends on the preparation of a hitherto almost unknown class of reagents, the α-alkenyl lithium derivatives, and on their reactions with a wide variety of secondary components[1].

One of the limitations to the manifold synthetic applications of Grignard reagents arises from the well-known fact that alkenyl halides containing a halogen atom adjacent to an ethylenic bond are very unreactive towards magnesium and can only be converted to the organo-magnesium derivatives with great difficulty. The only known exceptions to this rule are β-arylvinyl bromides, such as β-bromostyrene[2]. Vinyl bromide itself undergoes dehydrobromination to acetylene on treatment with magnesium[3], and the only successful attempts to employ substituted vinyl halides in Grignard condensations are those reported by Krestinsky[3], who found *iso*butenyl (β : β-dimethylvinyl) bromide (I) and *iso*amylenyl (α : β : β-trimethylvinyl) bromide to react with benzaldehyde and other aldehydes in the presence of activated magnesium and obtained some of the expected carbinols in small yields. In our hands, appreciable reaction between *iso*butenyl bromide and magnesium could only be induced in the presence of methyl iodide, and the yields of condensation products were only of the order of 10 per cent.

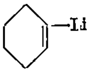
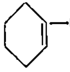
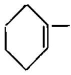
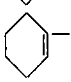
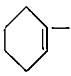
The present work originated in connexion with the projected synthesis of certain tautomeric systems not readily accessible by conventional routes; it appeared, however, that these systems would be readily obtainable from α-alkenyl-organometallic compounds. The difficulty of preparing Grignard reagents of this type, coupled with the incidence of additional complicating factors afterwards encountered in some of their reactions, directed our attention to the possibility of obtaining the corresponding lithium derivatives, since lithium often reacts more readily than magnesium with alkyl and aryl halides. The existing literature was not encouraging; the only lithium alkenyl previously described, styryl lithium, is stated to be formed no more readily than the magnesium derivative[2], and attempts to metalate vinyl bromide and 1-chloro*cyclo*hex-1-ene with butyl or phenyllithium are stated to be abortive[4]. We found, however, that highly purified *iso*butenyl bromide reacted readily with lithium metal in dry ether. Carbonation of the resulting solution with excess solid carbon dioxide and isolation of the products in the usual manner afforded a mixture of 2 : 5-dimethylhexa-2 : 4-diene (II; 35 per cent), β : β-dimethylacrylic acid (III; 7 per cent) and phorone (IV, 15 per cent). The ratio of acid to ketone produced depends on the conditions employed, while the proportion of diene is less affected.



The formation of α-alkenyl lithium derivatives proved to be quite general and by no means limited to β : β-disubstituted vinyl bromides, such as *iso*butenyl bromide, which cannot easily undergo dehydrobromination. Thus propenyl (β-methylvinyl) bromide readily reacts with lithium metal in ether to give propenyl lithium together with small proportions of propynyl lithium, and on carbonation a mixture of crotonic acid, dipropenyl ketone and tetrolic acid is obtained. Furthermore, alkenyl chlorides, which are often more readily prepared than the corresponding bromides, can be employed to advantage. Thus, 1-chloro*cyclo*hex-1-ene is converted by treatment with lithium followed by carbon dioxide into a mixture of *cyclo*hex-1-ene-1-carboxylic acid and di-(*cyclo*hex-1-enyl) ketone in an overall yield of 60 per cent.

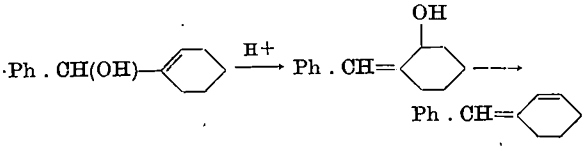
The ready formation of α-alkenyl lithium derivatives provides a new and convenient route to many types of ethylenic compounds, some of which have not been easily accessible hitherto. In some respects, this novel method of alkenylation complements the synthetic procedures employing acetylenic precursors which have recently been developed in these and other laboratories. α-Alkenyl lithium derivatives readily undergo the expected reactions with aldehydes and ketones to give ethylenic carbinols; with carboxylic acid derivatives to give ethylenic ketones, and with many other secondary components. Some examples are given in the accompanying table. The structures of the products were rigidly established, where necessary, by hydrogenation or selective oxidation and comparison with authentic derivatives.

Many of the compounds obtainable from α-lithium alkenyls undergo functional reactions and molecular rearrangements leading to other unsaturated systems. In particular, the ethylenic carbinols listed above readily undergo oxotropic rearrangements of the type previously described[5,6,7] to give, under acidic conditions, the isomeric substituted styryl or butadienyl carbinols, which can be dehydrated to substituted phenylbutadienes or hexatrienes. With the phenylalkenylcarbinols or symmetrical dialkenylcarbinols,

Lithium alkenyl	Secondary component	Product	Yield, %*
Me.CH=CH.Li	Ph.CHO	Me.CH=CH.CH(OH)Ph	35
,,	Me.CH=CH.CHO	Me.CH=CH.CH(OH).CH=CHMe†	40
Me_2C=CH.Li	Ph.CHO	Me_2C=CH.CH(OH)Ph	33
,,	Ph.CO.Me	Me_2C=CH.CMe(OH).Ph	25
,,	CH_2=CH.CHO	Me_2C=CH.CH(OH).CH=CH_2†	36
,,	Me.CH=CH.CHO	Me_2C=CH.CH(OH)CH=CHMe†	30
,,	Me.COOLi	Me_2C=CH.CO.Me	36
,,	Ph.COOLi	Me_2C=CH.COPh	40
,,	Me.CH=CH.COOLi	Me_2C=CH.CO.CH=CHMe†‡	30
	Ph.CHO	 —CH(OH).Ph†	40
,,	Ph_2CO	 —C(OH).Ph_2†	60
,,	CH_2=CH.CHO	 —CH(OH).CH=CH_2†	40
,,	Me.CH=CH.CHO	 —CH(OH).CH=CH.Me†	55

* Based on alkenyl halide.
† New compound.

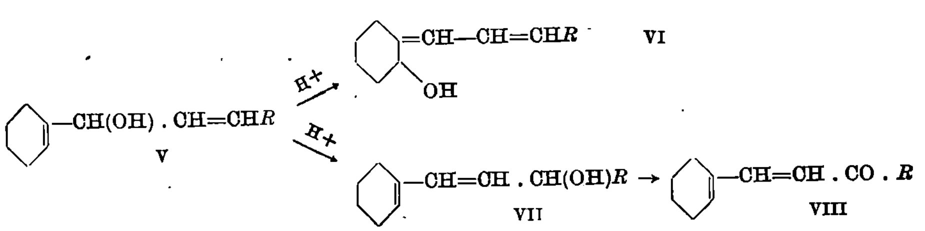
rearrangement can only give rise to one isomer; for example:



With the unsymmetrical dialkenyl carbinols, rearrangement can proceed in two directions; but it is found that under sufficiently mild conditions the hydroxyl group migrates almost exclusively to the more highly substituted γ-carbon atom. On prolonged acid treatment or under more strongly acidic conditions, this is often followed by a reversible five-carbon oxotropy:

$$Me_2C{=}CH\,.\,CH(OH)\,.\,CH{=}CHMe \xrightarrow{H+} Me_2C(OH)\,.\,CH{=}CH\,.\,CH{=}CHMe \xrightarrow{H+} Me_2C{=}CH\,.\,CH{=}CH\,.\,CH(OH)Me.$$

In the case of *cyclo*hexenylpropenylcarbinol (V, *R* = Me), both rearranged isomers are secondary carbinols, but only the isomer (VII, *R* = Me) is formed, whereas the lower homologue (V, *R* = H) yields exclusively the *cyclo*hexylidene derivative (VI, *R* = H). The utility of intermediates obtainable in this way is illustrated by the conversion of VII (*R* = Me) by Oppenauer oxidation into 4-(*cyclo*hex-1′-enyl)-but-3-ene-2-one (VIII, *R* = Me), a lower homologue of β-ionone recently synthesized by two other routes by Heilbron, Jones, Richardson and Sondheimer[8].



The range of existence of α-alkenyl lithium derivatives and some of their many potential synthetic applications are now being further studied in these laboratories. Detailed accounts of this work will shortly be published elsewhere.

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[1] Patent applications pending.
[2] Wright, *J. Org. Chem.*, 1, 457 (1936).
[3] Krestinsky, *Ber.*, 55, 2754 (1922).
[4] Wittig and Harborth, *Ber.*, 77 B, 306 (1944). Gilman and Haubein, *J. Amer. Chem. Soc.*, 67, 1420 (1945).
[5] Heilbron, Jones, McCombie and Weedon, *J. Chem. Soc.*, 84 (1945). Cymerman, Heilbron and Jones, *ibid.*, 90 (1945). Braude and Jones, *ibid.*, 128 (1946).
[6] Braude, Jones and Stern, *J. Chem. Soc.*, 396 (1946); 1087 (1947). Braude, Fawcett and Newman, *ibid.*, 793 (1950).
[7] Nazarov and Fisher, *Bull. Acad. Sci. U.S.S.R., Cl. Sci. Chim.*, 631 (1945); 311 (1948).
[8] *J. Chem. Soc.*, 737 (1949).

MOLECULAR MODELS

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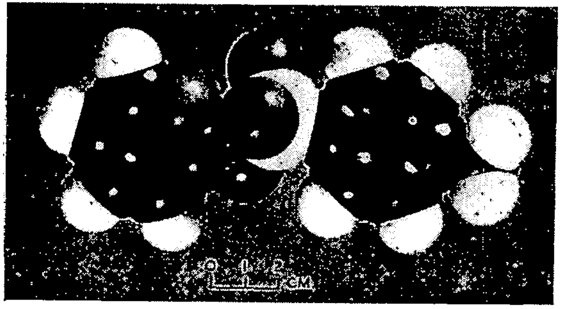
MOLECULAR models of the 'ball and spoke' variety are fairly readily available[1] in Great Britain, and devices for their fabrication have been described[2]. On the other hand, models approximating to the Stuart pattern[3] are much less readily available and are, in any event, expensive. Since for some purposes this type of model is to be preferred, an attempt has been made, first, to evolve an accurate specification, and then to consider the problem of fabrication, the general objectives being to stimulate interest in the subject and, if possible, to facilitate supply. The results of the investigation were exhibited at the recent Exhibition of the Physical Society, and commercial production of sets is in progress.

The specification was evolved after a survey of modern data, followed by the selection of dimensions which gave the truest possible stereochemical picture and are as free as possible from empirical 'adjustments' previously introduced on mechanical grounds. For each atom, in each state of combination, three basic dimensions are required: (i) bond-lengths; (ii) bond-angles; (iii) spherical size. The first two may be represented with a certain precision; but the last is less certain owing to the inherent difficulty of representing an atom by a solid material at the enormous magnification required. During this stage of the work, Prof. J. M. Robertson was good enough to afford us much helpful advice.

The problem of fabrication required, first, a decision as to size. It was considered that a scale of 1 cm. to 1 A. (10^8 : 1) represented a reasonable compromise between larger models, which would yield cumbrous molecules, difficult to view in perspective and presenting considerable problems of storage; and smaller ones, which would be embarrassingly difficult to assemble.

Various manufacturing possibilities were considered before deciding to utilize individual machining methods. The decision was made having regard to the relatively small and



Molecular model of 2-*p*-aminophenylsulphonamidopyridine

non-recurrent demand for sets including a wide variety of 'atoms' (say two dozen); to the high dimensional accuracy and the flexibility afforded by this method; and to the superior finish of the product. Moreover, the introduction of new 'atoms' would not involve the introduction of new tools.

Jigs were therefore devised whereby the models could be quickly and accurately turned out from any suitable material in rod-form using only the machine tool equipment likely to be standard in a small workshop. Compared with moulding techniques, the major disadvantage of the method is its costly nature; but this has been offset by the nature of the jigs and by ensuring that no wear of the expensive 'atoms' occurs during use. In any event, it is perhaps a difficulty more apparent than real, when the high cost of accurate moulds must be amortized over short runs.

The models consist basically of coloured spheres having diameters appropriate to the spatial requirements of the atoms concerned. These spheres are truncated in suitably oriented directions to an extent dictated by the co-ordinate radii of the atoms concerned; models of carbon (5 forms), hydrogen (1 form), nitrogen (6 forms), oxygen (2 forms), sulphur (3 forms) and halogens constitute the greater part of a useful set of 250 units, although other 'atoms' may readily be produced by the methods described.

The material used is a cast phenolic resin, which has good machining properties and is readily procurable in a range of suitable diameters and colours. The units are pleasant to handle and are hard wearing.

Jointing is carried out with detachable pegs of hard rubber, a material which is durable, does not cause wear on the relatively expensive units yet allows axial rotation, and gives sufficient flexibility for slight stressing of the molecule when required. Provision for locking individual units (double bonds) is made with small steel pins which are inserted as applicable.

Fabrication. Rod material of selected diameter is faced, centred in a lathe and parted off to form a cylinder slightly greater in length than the finished truncated ball. The faced end is then drilled and threaded with a tapping device in a drilling machine and afterwards held in a lathe on a threaded mandrel and machined to finished diameter using the ball turning fixture.

Additional facets are located at the required angles in a milling machine using the dividing head, the truncated ball being held as before on a threaded mandrel. Machining the facets to desired depth is completed in a lathe after each face has been set square from the tail-stock by a parallel distance piece. A special chuck facilitates this operation. Each facet in turn, including the threaded hole, is also drilled to take the rubber peg connexion. The units requiring holes to take the double-bond locking pins are bored in a drilling machine using the jig fixture, which locates the holes accurately and in correct relationship to the facets. The rubber pegs are cut from hard synthetic rubber cord and the locking pins from ground-steel wire afterwards polished.

It is of interest that an 'aromatic carbon' may be made from rod in a machining time of 6½ minutes.

We are indebted to Mr. A. Neal, of the Dunlop Rubber Company, and to Dr. Tudor Jones, of the Wellcome Research Laboratories, for much helpful discussion.

The work was carried out as part of the programme of the Chemical Research Laboratory of the Department of Scientific and Industrial Research, and this contribution is made with the permission of the Director. The prototype sets were made in the workshops of this Laboratory.

[1] Wooster, McGowan and Moore, *J. Sci. Instr.*, **26**, 140 (1949).

[2] Evans, R. C., *Rev. Sci. Instr.*, **19**, 402 (1948). Haywood, C. A., private communication.

[3] Stuart, *Z. phys. Chem.* (B), **27**, 350 (1934).

THE GESTURAL ORIGIN OF LANGUAGE

EVIDENCE FROM SIX 'UNRELATED' LANGUAGES

By Prof. ALEXANDER JÓHANNESSON
University of Iceland

In previous articles[1] in *Nature* I have shown that human speech consists mainly of gesture sounds, and I have substantiated this theory by comparing the 2,200 constructed *IE* roots with the Semitic roots, as represented by Hebrew, which has approximately the same number of roots as Indo-European languages. Human speech consists of emotional sounds, nature sounds, and of gesture sounds which are spontaneous imitations by the speaking organs to designate the form or shape of things in Nature or movement. In my last article in *Nature* I showed that the *l* and *r* sounds are of double origin, partially imitations of Nature sounds and partially sounds made by lifting the tip of the tongue to the soft palate to designate the shape or form of things in Nature or movement. This is mostly seen in roots consisting of vowel plus *l* or *r* or consonant plus vowel plus *l* or *r*. It seems that the most primitive form of these gestural sounds was the connexion of a throat or back palate sound with *l* or *r*, such as *gel* (*kel*), *ger* (*ker*), etc., and this is very clearly seen not only in Indo-European and in Semitic languages, but also in archaic Chinese, Polynesian, Sumerian and even Greenlandic (cf. the above-cited article in *Nature*). It is of no great importance whether the velar (guttural) sounds are *g*, *gh*, *k*, *q*, etc.; comparative philology shows that the consonants are the basic element in every language. Velars always remain velars, labials remain labials, dentals remain dentals —and there are very few exceptions to this rule. The vowels, on the other hand, are very fluctuating, changing from time to time through the influence of their neighbouring sounds.

In an essay, which will be published later, I have undertaken to scrutinize the roots, which consist of a

A type : velar (guttural) + vowel + u(w)

	Indo-European	Hebrew	Arch. Chinese	Polynesian	Turkish	Greenlandic
(1)	*ĝheu* = to pour (Gr. χέω)	*qw-a* = to spew out	*g̭iw-an* = to flow		*gev-ış* = chewing the cud	*kîv-â* = presses together
(2)	*geu* = to bend (Gr. γυρος, 'round')	*qw-ph* = to go round	*g̭iw-o* = to bend	*kuw-ha* = the thigh	*kav* = cave, vault	*qiv-erpoq* = bends
(3)	*sqeu* = to cover (Lat. ob-scū-rus)	*ehw-m* = to be black (covered)	*g'w-âd* = lid, cover		*lav-ram* = embracing	
(4)	*qāu* = to cut (Engl. to hew)	*gw-b* = to cut	*kiw-at* = cut off	*haw-a* = chipped	*cav-lak* = peeled off	*kiv-dlorpâ* = cuts off its length
B type : velar (gutt.) + vowel + b (bh, p, ph)						
(1)	*qap* = to grasp (Lat. cap-io)	*gb-a* = to gather together	*g'iap* = to grasp, hold	*hop-u* = to catch, seize	*kap-ış* = seizing, snatching	*qâp-oq* = sticks in something
(2)	*qamp* = to bend (Gr. καμπή, 'bending')	*gb-b* = to be curved	*kap* = cyclical character	*hap-a* = crooked	*kuf-a* = round boat	*qûp-ôq* = keg, jar (the curved form)
(3)	*(s)qep* = to cover (Gr. σκέπας)	*kp-r* = to cover	*g'âp* = to cover	*kap-i* = to be covered	*kab-alak* = head-cover	*qáp-ivoq* = disappears below the water, the sea closes over it
(4)	*ĝeb(h)* = branch (cut-off) (Icel. kaf-li)	*hb-r* = to cut	*xiăp* = to break ?			*qap-erpâ* = cuts it with a pair of scissors
C type : velar (gutt.) + vowel + m						
(1)	*gem* = to press together (Ags. cum-ul, 'swelling of glands')	*ehm-ş* = to oppress	*g'i̥am* = to pinch	*ham-a* = to be consumed	*gem* = bit (of a bridle)	*qim-ípâ* = strangles him
(2)	*qam* = to bend (Lat. cam-ur, 'vaulted')	*qm-š* = to be curved	*k̭iəm* = collar, sash, string	*ham-u* = the back of the skull	*ham-ut* = collar, yoke	*qim-eriaq* = eyelash (the curved)
(3)	*k̂em* = to cover (German hem-d)	*hm-r* = to cover with bitumen	*g'i̥əm* = black (covered ?)			
(4)		*qm-d* = to cut off				*qum-arpoq* = becomes shorter

velar (guttural) sound + vowel + labial, of the type *geb*, *gem*, *geu* in six 'unrelated' families of languages, namely, Indo-European, Hebrew, Archaic Chinese, Polynesian, Greenlandic and Turkish. The meanings attached to this type of word-forming are very clearly seen in all these languages and it will be clear that differences between the velars (*g*, *gh*, *k*, *kh*, *q*, etc.) or labials (*b*, *bh*, *p*, *ph*, etc.) are of insignificant importance. Instead of the type *geb* we can have *gheb*, *keb*, *qeb*, *ghabh*, *kap*, etc.

It must be remembered that in unconsciously imitating shapes and gestures, the tongue and lips frequently work together, so that, for example, a movement commenced by the tongue may be completed by a lip movement. Thus, in producing the sounds *geb*, *gem*, *geu(w)*, etc., we move the backward portion of the tongue forward towards the lips so that the gesture as a whole represents a curved movement. In producing the sounds *geu(w)*, we finish the movement by rounding the lips; in producing the sounds *gem* we finish the movement by closing the lips; and in producing the sounds *geb* (*gebh*, *gep*, etc.) we finish the movement by only partially closing the lips or by closing them and opening again. It is therefore very natural that words made or derived from these roots designate: (1) to eat, hold in the mouth, to grasp, to contain, to close, to press together, to complete, to finish; (2) curved, vaulted, round, to swell, etc. The comparison of the whole material in the six families shows that the following meanings have developed: (3) to cover, hide, etc.; (4) to cut. Examples are given in the accompanying table.

Of 85 Indo-European roots belonging to the three types (*geu*, *gem*, *geb*, etc.), 63 show one or the other of the postulated meanings. Of 144 words in Hebrew, 92 (or 63 per cent) give the same result. In Archaic Chinese 90 roots of 107 in one way or another show similar meanings (or about 84 per cent). In Polynesian I have collected fifty examples, which are all in accordance with the postulated meanings. In Turkish I have collected (assisted by a Turkish linguist, Cemal Enisoğlu, in Trabzon) 72 roots (the overwhelming majority of the Turkish roots of this type). The total number of these roots in Greenlandic is 101; of these 68 (or 67 per cent) are in accordance with the results obtained in the other languages. The dispersion of the four variations of meanings in the six languages is very unequal, as will be seen in the following summary:

	Indo-European	Hebrew	Arch. Chinese	Polynesian	Turkish	Greenlandic
(1)	15 roots	31	27	13	13	21
(2)	30	42	63	32	49	25
(3)	5	10	11	3	9	5
(4)	8	12	13	2	1	17

This shows very clearly that the two most natural meanings of these sounds, produced by moving the jaws from behind forwards to the lips, are contained in the first two groups. Besides the meaning to eat, hold in the mouth, grasp, contain, close, etc., the meaning curved, vaulted, round, etc., has developed and, probably later, to cover, hide and cut. In the roots of every language we see more or less the 'fossils' of human speech, and it will be possible, by comparing the various sound-groups of the languages of the world, to reconstruct the main characteristics of human speech in its genesis.

[1] *Nature*, 153, 171 (1944); 154, 466 (1944); 157, 847 (1946); 162, 902 (1948).

SPECTROSCOPIC BINARIES

GEORGE DARWIN LECTURE

PROF. OTTO STRUVE, chairman of the Department of Astronomy, University of Chicago, and director of the Yerkes and McDonald Observatories, was awarded the Gold Medal of the Royal Astronomical Society in 1944; but owing to war conditions he was unable at the time to be present to receive it and to deliver the George Darwin Lecture. On October 14, 1949, Prof. Struve gave the Lecture to the Royal Astronomical Society at Burlington House, taking for his subject "Spectroscopic Binaries". His address has already been published in full (*Mon. Not. Roy. Astro. Soc.*, 109, 5; 1949) and also in a slightly abbreviated form in *The Observatory* (69, 853; Dec. 1949).

Special attention is given by Prof. Struve to the well-known eclipsing variable *U* Cephei, which has been investigated by some of the best-known photometric workers. The light curve supplies an accurate determination only of $e \cos \omega$, where e is the eccentricity of the orbit and ω the longitude of periastron, and each of these can be determined separately only when $e \sin \omega$ is also known. In 1930 E. F. Carpenter at the Lick Observatory, California, found by means of a spectrographic study an unsymmetrical velocity-curve from which he deduced that e is 0·47 and ω 25°, which implies that $e \cos \omega$ is 0·43. This would mean that the secondary eclipse could not be half-way between two primary eclipses, but should occur about twelve hours later than had been observed with the photometer. As an error of only a few minutes can occur in the secondary eclipse, it was impossible to explain the discrepancy on the assumption of ordinary Keplerian motion.

In 1943 Struve obtained a new velocity-curve of the binary at the McDonald Observatory; the star, the light of which was observed, except for a few hours, at total eclipse, was of spectral type *B*8 or *B*9, and an unsymmetrical curve resembled that obtained by Carpenter, but some aspects of the curve proved puzzling. Among these may be noticed the tendency of the measures to fall systematically above the computed curve between phases 0·8 day and 1·6 days, but between 1·6 days and 1·9 days many points fell below the computed curve. During the past few years there has been confirmation of the view that many close binaries are enveloped in streams of gas which revolve like whirlpools around and inside the system, so that the components do not obey the laws of the two-body motion. When the amount of gas projected in front of the photosphere of the bright binary component is large, the great streams of gas produce absorption lines. Emission lines are produced when large masses of gas, excited by the *B*-type component to emit the Balmer lines of hydrogen, are projected upon the black background of the sky. Certain important conclusions follow from these new ideas.

It may be assumed that the velocity-curve of *U* Cephei is symmetrical, and by a few adjustments the maximum of the true-velocity curve falls approximately at phase 1·83 days, corresponding to a radial velocity of about −80 km./sec. A sketch of this curve in Fig. 2 of the Lecture shows, however, that it is much better represented at phase 0·2–1·8 days; but that after this the observed points are mostly positive—facts which seem to contradict the proposed hypothesis. The objection is not, however, valid, because the hydrogen lines are known to have strong and fairly sharp violet-displaced cores in absorption just before and after first contact, and it is suspected that, near the observed maximum of the velocity-curve, cores were displaced towards the red side of the broad wings of the *H*-line. These displaced cores almost certainly distort the velocity-curve in the sense of raising the measured velocities between phases 1·8 and 2·2 days and depressing them after 2·2 days, a view which is supported by other evidence. The case of *U* Cephei is not unique, and in a number of other systems the same phenomena are in evidence. It seems that in all, or nearly all, eclipsing variables the periods of which are approximately 2–5 days, and also in a number of other systems of longer period, gaseous streams produce blended absorption lines which distort the velocity curve primarily at phases 0·8–1·0, and to a smaller extent at 1·0–0·2, of the period. In addition, the evidence suggests that the motion of the stream is not entirely due to a single mass of gas.

There is no certainty that gravitational forces alone are active, for electric and magnetic forces may also play an important part; and a model which meets the observations is proposed; but no attempt is made to justify it theoretically. On the assumption that the flow occurs mostly between two successive equipotential curves in the *XY*-plane, then

$$(1 - \mu)/r_1 + \mu/r_2 + \tfrac{1}{2}(x^2 + y^2) = \tfrac{1}{2}C,$$

where $\mu = m_2/(m_1 + m_2)$, $1 - \mu$ and μ are the forces producing the equipotential curves, and r_1 and r_2 are the distances of the centres of force from the point under consideration. On the assumption that the motion is uniform, or nearly so, between the two inner curves shown in Fig. 12 of the Lecture, then at all phases between $0{\cdot}15\,P$ and $0{\cdot}85\,P$ the line of sight would project upon the disk of the small *B*-star different sections of a formation which is nearly circular in the *XY*-plane, and hence shows no radial component of velocity between the stream and the centre of the *B*-star. If the gases were excited to emit *H*-lines, double bright lines could be observed, as actually happens in *RW* Tauri, *SX* Cassiopeiæ, *RX* Cassiopeiæ, *RZ* Ophiuchi, etc. Although the proposed model is consistent with a number of observational data which are referred to in the Lecture, a theoretical explanation of the model is very difficult, and it will suffice to sum up some of the conclusions to which Struve has been led.

All close binaries possess the common gaseous envelope referred to, and, as they cannot be dynamically stable, they probably play an important part in the evolution of binaries. The envelopes are ring-like and flow round the system with velocities of several hundred km./sec.; but from the dilution effect it is estimated that their extent is not larger than two or three times the diameter of the brighter star. The thickness of the ring is greater in the direction of motion of each star, and a range in the velocity of expansion of the ring appears to lie between 0 and 100 km./sec., though accurate measurement is difficult. In the system *UX* Monocerotis and also in several Wolf-Rayet binaries, violent motions away from the *G*-type subgiant component are considered to afford evidence of prominence activity. In the former system they seem to be concentrated in one hemisphere, and produce a gradual diminution of the star and probably in its angular momentum as well.

In the case of β Lyræ, where the *G*-component is small in size, the absorption effects of the stream can be observed with great clarity, and these yield the satellite lines discovered by Baxandall. There is a general tendency among spectroscopic binaries with periods of 2–5 days to give distorted velocity-curves simulating large eccentricities and values of ω in the vicinity of 40°, and statistical discussions by Miss Scott and others have shown that a large number of eccentricities of spectroscopic binaries must be spurious. Where the distortion of the velocity curve can be directly measured, a mass of gas is seen projected in front of the receding *A*-type star, beginning soon after the maximum radial velocity of the latter and preceding the beginning of the partial eclipse. It is very pronounced in *U* Cephei, but is only slightly indicated in *U* Sagittæ. An approximate picture of the flow of gas within the envelope, using the data from several stars, indicates roughly a Jacobian equipotential curve in the XY-plane. The amount of matter in a typical ring, on a rough estimate, is 10^{-8} times the mass of the brighter component. Assuming that the average tendency to expansion is less than 1 km./sec., most of the mass of the binary would be exhausted in 10^8 years. If angular momentum were lost with this mass, as seems probable, a system of the type of *U* Sagittæ or even of Plaskett's star could gradually evolve until it became a typical *W* Ursæ Majoris binary. If the evolutionary trend continued in the direction of bringing the two components together, some mechanism must exist to take care of the excess angular momentum; and here an interesting view is propounded: one possibility might be the transformation of a *W* Ursæ Majoris system into a slowly rotating red dwarf and a group of attending planets which absorb the greater portion of the angular momentum of the binary in their orbits.

DEVELOPMENTS IN THE HEAT TREATMENT OF MILK

THE Society of Dairy Technology, at its meeting at the Conway Hall, London, on April 21, discussed developments in the heat treatment of milk.

Mr. A. Rowlands dealt with the bacteriological aspects. He said that heat treatment is now accepted as an essential process in the handling of liquid milk and in the manufacture of most dairy products. Because of its relatively high resistance to heat, complete destruction of the tubercle bacillus is the accepted criterion of satisfactory heat treatment. There is abundant evidence of the large margin of safety provided by treatment of milk at 145–150° F. (62·8–65·6° C.) for thirty minutes as required in Great Britain for holder pasteurization. Nor is there any doubt about the safety of milk treated in commercial plants at 161° F. (71·7° C.) for fifteen seconds as required in the high-temperature short-time process: the holding time in commercial plants is, in general, appreciably longer than fifteen seconds. There is, however, need for a laboratory apparatus in which the time of heating and cooling is minimal and in which the time of holding can be controlled positively. Such an apparatus is necessary to obtain more exact information about the time–temperature combination required to destroy tubercle bacilli and other pathogens and non-pathogens in the higher temperature range.

Commercially, the improvement in the keeping quality of milk resulting from heat treatment is extremely important, and Mr. Rowlands said it is difficult to see how the community could be supplied with milk possessing an adequate keeping quality without heat treatment. Raw milk sometimes contains large numbers of thermoduric bacteria derived mainly from unsterile utensils used on farms, but, fortunately, these types have only a slight effect on the keeping quality of the pasteurized milk stored at normal household temperatures. At these temperatures spoilage is generally the result of contamination of milk after pasteurization from the surfaces of coolers, pipe-lines, storage tanks, bottle-fillers and bottles. Pasteurization, coupled with efficient cleaning and sterilization of all plant to prevent subsequent re-contamination, ensures a keeping quality adequate to satisfy consumer requirements. Nevertheless, the thermoduric bacteria derived from the raw milk sometimes make it difficult to comply with colony count standards which might be applied to the bottled milk. These thermoduric bacteria are for the most part slow dye-reducers and are unlikely to account for failure to comply with the half-hour methylene-blue test standard now in use officially for the examination of pasteurized milk in England and Wales.

Pasteurization does not destroy spores, and there is evidence that some spore formers cause stimulation of acid production by the lactic acid streptococci. Spore-forming aerobes are also associated with the fault 'broken' or 'bitty' cream; this fault is readily apparent in tea or coffee in the form of large particles of curdled cream floating on the surface. Research in progress at Shinfield has shown that the fault is caused by *Bacillus cereus* and *mycoides*; both produce an enzyme (lecithinase), and broken cream is thought to be associated with the action of this enzyme on the lecithin fraction of the fat-globule surface membrane.

Thermophiles, which were at one time a serious problem with the holder process of pasteurization, cause little trouble with the high-temperature short-time process. Temperatures used with the latter are above the optimum for the growth of thermophiles. Recently it has been found that thermophiles are sometimes concerned in the spoilage of sterilized milk. Thermophiles, the spores of which possess unusual resistance to heat, survive the commercial sterilization process and later proliferate at a stage during the slow cooling of the stacked bottles.

Dr. R. Seligman dealt with the history of pasteurization from the engineer's point of view. He divided the time which has elapsed since Pasteur's day into two periods, the first ending in 1922. During this period little attention was given by British engineers to the design and development of equipment for the heat treatment of milk, and Great Britain was obliged to depend largely on imported equipment. In contrast, during the second period most of the equipment developed and now in general use throughout the world had its origin in patents first granted to British engineers.

A German patent granted to Fesca in 1881 marked the first real contribution of the engineer in the field of heat treatment of milk. This was a continuous heater, and later, as the Danish or rotary pasteurizer, it was used extensively for many years in Europe and America. Internal tubular heaters, either with the tubes permanently fixed in position or with the inner tube detachable to facilitate cleaning, were developed early in the present century. Heaters of the latter type were used for regenerative heating, as were also surface heaters or coolers of the Baudelot type.

For low-temperature pasteurization, batch pasteurizers of the coil-vat or spray-vat type were in widespread use during the early years of the present century. Owing to the protracted period of heating and cooling, these possessed many disadvantages and were entirely unsuitable for dealing with large quantities of milk. Flow-retarding tanks in which the milk flowed continuously through a number of tanks in series were introduced by Heulings in 1895. Later, the so-called 'absolute' holders with independent heaters and coolers gained some prominence. Patents granted to a British engineer, Tarbet, in November 1922 marked a major advance in the process of holder pasteurization, for he was the first to accomplish the automatic holding of milk for a fixed time at the required temperature and without risk of contamination of the pasteurized milk with raw or partly pasteurized milk.

In 1923 a major development occurred which was later to revolutionize the methods in general use for the heat treatment of milk. This was a patent granted to Dr. Seligman for a heat exchanger of the plate type, and he explained that the plate-heat exchangers now used so extensively in the milk industry were developments of the 1923 British patent. The original cast plates have now been largely replaced by pressed stainless-steel plates with bosses or grooves to provide the necessary turbulence.

Special holder-plates, developed originally for the retardation of flow of milk treated at the higher temperatures, have been largely replaced by flow holders of the tubular type for the high-temperature short-time process. These tubular holders are accurately proportioned to the rate of flow, which is itself accurately controlled to secure the necessary holding time of fifteen seconds. The introduction of the high-temperature short-time process has also demanded accurate control instruments, and the 'diversion valve', designed automatically to divert underheated milk from the main stream, has been perfected. Electrical heating, originated by Beattie and Lewis in Liverpool in 1917, is now in use commercially in some high-temperature short-time plants in the United States.

A. Rowlands

AMERICAN EDUCATION

IN the United States the Office of Education forms one department of the Federal Security Agency. In his annual report to the Federal Security Administrator for 1949, the Commissioner for Education directs attention to inadequacies in the educational system which sound very familiar to educationists in Great Britain. The teacher shortage, for example, bears a striking similarity to the position in Britain. During 1948–49 approximately 28,000,000 children enrolled in the elementary and secondary schools, and a startlingly rapid increase in this number has already begun. By 1960 the number of children enrolled in elementary and secondary schools will be about 37,000,000, with the most rapid increase occurring in the three school years beginning in 1952, 1953 and 1954. The available teachers fell far short of the number needed even to staff the classes assembling in the autumn of 1949. This shortage exists largely among elementary school teachers, and in many communities the shortage of teachers has resulted in classes of more than fifty children. In others education has been curtailed by dividing the school day into two sessions, one group of children attending in the morning and another in the afternoon. Thousands of classes are taught by teachers who hold only emergency or temporary certificates.

Income is a significant factor in recruiting and keeping teachers in the profession, but is by no means the only one. The status which the teacher occupies in the community, the regard of the public for the work of the schools, the opportunity to live a normal life unhampered by local conventions and projects and a number of other psychological and social factors are no less important. In too many communities in the United States teachers are required to adapt their own tastes, conduct and social activities to those of members of the school board or other prominent citizens. They are often expected to lead an abnormally restrained and inhibited life compared with the life of the parents who impose such restrictions.

The critical shortage of teachers is matched by an arresting lack of schools. If all the needed teachers were available to-day many would have no suitable rooms in which to conduct their classes. A shortage of school buildings is in part the result of the depression of the 30's and in part the result of restrictions on construction during the war years. As a result, many children must attend classes conducted in obsolete, insanitary and frequently dangerously dilapidated structures. Many of the buildings which are physically sound are inadequate in terms of the functions of modern education. Some teachers during 1948–49 were conducting their classes in church basements, factories and stores and other unusual locations. It is difficult to say how serious is the shortage of classrooms; but, assuming thirty to be a suitable number in any one class, the number of new classrooms required each year to accommodate new enrolments up to 1958 will be approximately 25,000.

One interesting section in the report deals with the place of Communism in the schools. In the spring of 1949 the Educational Policies Commission of the National Education Association issued a report which makes four specific recommendations.

(1) Young citizens should have an opportunity to learn about the principles and practices of totalitarianism, including those represented by the Soviet Union and by the Communist Party in the United States.

(2) Teaching about Communism or any other form of dictatorship does not mean advocacy of these doctrines. Such advocacy should not be permitted in American schools.

(3) The schools should continue with vigour their programmes for giving young citizens a clear understanding of the principles of the American way of life and a desire to make these principles prevail in their own lives and in the life of their country.

(4) Members of the Communist Party of the United States should not be employed as teachers.

These proposals are supported by the Commissioner, who argues that children are not sent to school to be indoctrinated with a closed system of philosophy or the political views of the teachers. To the extent that education becomes dogmatic indoctrination, it ceases to be education.

"The Communist embraces and teaches dogma. He is, by his Party membership and sympathy, committed to a closed system of thought. He has given his allegiance to a predetermined set of principles which are not to be evaluated in the light of evidence or examined on the basis of results. He is not free to serve the truth as the evidence may uncover that truth. He has therefore surrendered his right to teach in a nation of free people. In this the Communist is not alone, of course; but the fact that there are those others whose commitments prevent them in some measure from pursuing the truth does not justify the retention of Communists."

The report also contains valuable sections giving details of educational research and statistics, the administration of grants, programmes of organisation and administration, programmes of instruction, programmes for improving the professional status of teachers, and, finally, the position of the United States in international educational relations.

T. H. Hawkins

LETTERS TO THE EDITORS

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Antibacterial and Antifungal Activity of Benztropolone

FOLLOWING the suggestion of Dewar[1], it is now generally accepted that the mould metabolic products, stipitatic acid, puberulic acid and puberulonic acid are derivatives of tropolone[2]. Erdtman and Gripenberg[3] have shown that α-, β- and γ-thujaplicins from *Thuja plicata*, the western red cedar tree, are, respectively, α-, β- and γ-*iso*propyltropolones. γ-Thujaplicin was found to possess fungicidal activity; when spores of *Pullularia pullulans* were suspended in a 0·02 per cent solution, 100 per cent survived after 1 hr., 11 per cent after 3 hr. and none after 6 hr. and 24 hr. exposure. Two of us (J. W. C. and A. R. S.) have recently described a synthesis of 3 : 4-benztropolone[4].

We have found that 3 : 4-benztropolone is fungistatically active; at the highest concentration tested, specific fungicidal properties towards a few species were observed. The compound has weak bactericidal activity. We are indebted to Prof. H. Erdtman for a specimen of γ-thujaplicin, which was included in our tests for comparative purposes. Preliminary solubility tests showed that under the conditions of the spore germination and fungicidal tests the saturation point, which represented the highest possible effective dose of benztropolone, lay in the range 50–100 mgm./litre; γ-thujaplicin was more soluble.

Spore germination test. Spores of *Penicillium digitatum* were suspended in a series of concentrations of the substances in 'spore germination medium'. The percentages of spores which germinated after 18 hr. at 25° were estimated. Benztropolone allowed 50 per cent germination at 80 mgm./litre concentration and γ-thujaplicin at 60 mgm./litre. In a parallel experiment, trichothecin[5] completely inhibited germination at 1·25 mgm./litre, and 50 per cent germination took place at 0·4 mgm./litre.

Fungistatic activity. A series of concentrations of the substances in the range 0·6–80 mgm./litre was incorporated in nutrient medium on which the test organisms were sown. Growth was estimated visually after five days incubation at 25°.

Benztropolone gave complete inhibition of all the test organisms at 80 mgm./litre and partial inhibition of growth at 16 mgm./litre. γ-Thujaplicin was somewhat less active and caused only partial inhibition of growth of *A. niger*, *M. erectus*, *P. digitatum* and *Trichoderma viride* at 80 mgm./litre. In parallel experiments, sodium pentachlorophenate and tetramethylthiuram disulphide caused complete inhibition of *P. digitatum* and *F. graminearum* at 16 mgm./litre and partial inhibition at 3·2 mgm./litre.

Fungicidal activity. Spores of six test fungi and cells of *S. carlsbergensis* were suspended in solutions of benztropolone and γ-thujaplicin (50 mgm./litre) and incubated at 25° for 53 hr. Loopfuls of the suspension were taken at intervals and plated on to beer-wort agar medium. After five days incubation at 25°, the colonies were counted. Both benztropolone and γ-thujaplicin were fungicidal to *Pullularia pullulans* (De Bary and Low) Berkhout (laboratory collection No. 273); in a solution of the former, approximately 12 per cent of the spores survived after 24 hr., 8 per cent after 33 hr., and none after 53 hr.; the corresponding results for γ-thujaplicin were 12 per cent survivors after 24 hr., 6 per cent after 33 hr. and none after 53 hr. Similar results were obtained with *Trichothecium roseum* spores, 30 per cent of which survived 24 hr. in benztropolone solution, 10 per cent survived 33 hr., and none was viable after 53 hr. In γ-thujaplicin solution, 50 per cent of *T. roseum* spores were viable after 7 hr., 25 per cent after 24 hr., and none after 33 hr. Exposure to solutions containing 50 mgm./litre of benztropolone or γ-thujaplicin for 53 hr. had no effect on the survival of spores of *Aspergillus niger*, *Penicillium digitatum*, *P. nigricans-janczewskii* series, *Trichoderma viride* or cells of *Saccharomyces carlsbergensis*.

FUNGISTATIC ACTIVITY OF BENZTROPOLONE AND γ-THUJAPLICIN: PLATE TEST

Laboratory collection No.	Organism	Relative growth at benztropolone concentrations (mgm./litre)				Relative growth at γ-thujaplicin concentrations (mgm./litre)				Control
		80	16	3·2	0·6	80	16	3·2	0·6	
*F*160	*Aspergillus niger* van Tiegh.	0	3	4	4	2	3	4	4	4
*F*197	*Fusarium graminearum* Schwabe	0	2	4	4	–	–	–	–	4
*F*266	*Mucor erectus* Bain.	0	3	4	4	2	4	4	4	4
*F*196	*Penicillium digitatum* Sacc.	0	2	4	4	1	3	4	4	4
*F*211	*P. nigricans-janczewskii* series	0	3	4	4	0	3	4	4	4
*B*55	*Saccharomyces carlsbergensis* Hansen	0	3	4	4	0	3	4	4	4
*F*5	*Trichoderma viride* Pers. ex Fries	0	2	4	4	1	3	4	4	4
*F*292	*Trichothecium roseum* Link	0	3	4	4	0	3	4	4	4

Key: No growth, 0; trace of growth, 1; slight growth, 2; good growth, 3; abundant growth as control, 4; not tested, –.

Bactericidal activity. *Staphylococcus aureus* survived 3 hr. in benztropolone solution (50 mgm./litre) at 25°, but not 7 hr. *Bact. coli* was viable after 7 hr. under these conditions, but not after 24 hr. *Aerobacter aerogenes* was not killed after 53 hr. exposure. γ-Thujaplicin had no bactericidal effect at 50 mgm./litre concentration on *Staph. aureus*, *Bact. coli* or *Aerobacter aerogenes* after 53 hr.

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A Novel Method of using Ion-Exchange Resins

WHEN considering a chromatographic method for separating a complex mixture, it is desirable to choose an adsorbent which functions through only one type of adsorption mechanism. Most adsorbents in use to-day lack this desirable property, so that the displacement chromatographic technique of Tiselius is not always applicable. It is the purpose of this communication to describe a novel chromatographic method of using ion-exchange resins so that only one of two possible adsorption mechanisms associated with their use can function.

Weak organic electrolytes and, in particular, aromatic organic ions can be adsorbed on an ion-exchange resin by a combination of salt linkages and Van der Waals' adsorption forces, if the electrical charge of the resin has the opposite sign to that of the organic ions. Partridge[1] and Davies[2] have recently discussed the deleterious effects arising from the simultaneous operation of these adsorption mechanisms and have shown that a major limitation of ion-exchange resins to-day is their inability to fractionate mixtures containing aromatic molecules.

It is suggested that these difficulties can be resolved if aromatic molecules are adsorbed on a dissociated ion-exchange resin the electrical charge of which has the *same* sign as the aromatic ions. Under these conditions only the undissociated aromatic molecules can be adsorbed, since the corresponding ions cannot approach the surface against its repulsive electrostatic forces. Any change in *p*H which dissociates the adsorbed aromatic molecules will result in their desorption.

The use of ion exchange resins in this manner is illustrated by the following experimental observations. Acid dyestuffs, such as Methyl Orange, Fast Red A (Colour Index No. 176), and Chicago Blue (Colour Index No. 518), are adsorbed by the carboxylic resin 'Amberlite *IRC*-50' in its undissociated state in acid solutions, whereas no adsorption occurs in alkaline regions where the resin and the dyes are fully ionized. Similarly, the basic dyestuff, Methylene Blue, is adsorbed by the polyamine resin 'Amberlite *IR*-4B' under alkaline conditions where the resin is unionized; but addition of acid completely desorbs the previously adsorbed dyestuff.

In solutions of high ionic strength and suitable *p*H, ions as well as their corresponding undissociated molecules may be adsorbed on the undissociated resin by the Van der Waals' forces. This difficulty may be avoided by using a resin which is dissociated during the adsorption and desorption cycles, and this procedure ensures the adsorption of only undissociated molecules. For example, the acid dyestuff Methyl Orange is adsorbed by the sulphonic resin 'Amberlite *IR*-120', under acid conditions in which the resin, but not the dyestuff, is ionized. Complete desorption occurs upon the addition of alkali, which ionizes the adsorbed dye molecules. Similarly, the basic dyestuff Neutral Red (Colour Index No. 825) is adsorbed by the strongly basic resin 'Amberlite *IRA*-400' under alkaline conditions in which the resin, but not the dyestuff, is ionized. Complete desorption occurs upon the addition of acid, which ionizes the adsorbed dye molecules.

These principles explain many anomalies in the literature, including the recent work of Abrams and Dickinson[3], who studied the decolorization of sugar solutions with polyamine resins and with the new decolorizing 'non-ionic' phenolic-type resin, 'Duolite *S*-30'. When used for decolorizing sugar solutions, these resins can be regenerated by treatment with a small amount of sodium hydroxide. Desorption results from the ionization of the phenolic groups of these resins and the expulsion of the previously adsorbed colouring matter, which is known to be a mixture of weak organic acids.

The use of ion-exchange resins in the manner outlined here will be considered in greater detail from theoretical and experimental aspects in a publication to appear elsewhere.

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Separation of Carboxylate Ions on the Paper Chromatogram

THE work of Martin and Synge[1] on the separation of amino-acids by partition chromatography on silica gel has led to the application of this method to the separation of other groups of structurally similar compounds. Lester Smith[2] and Ramsey and Patterson[3,4] have separated by this means the straight-chain fatty acids containing one to ten carbon atoms, and Elsden[5] has put the procedure on a quantitative basis in the case of acetic, propionic and *n*-butyric acids.

Since paper partition chromatography affords an equally effective and even simpler method of separating mixtures of closely related compounds, we have attempted to apply the latter method to the separation of the lower fatty acids, with the ultimate aim of identifying the acids produced in bacteriological culture media. Lugg and Overell[6] succeeded in separating quantitatively mixtures of citric, malic and tartaric acids, using butanol – acetic acid as the mobile phase. The positions of the acids after development of the chromatogram were detected by spraying the dried paper with Bromophenol Blue or Bromocresol Green. The volatility of the lower fatty acids, however, imposes a severe limitation when applying this method to their separation. An attempt was made by Fink and Fink[7] to overcome this difficulty by chromatographing the potassium hydroxamate derivatives prepared from the corresponding methyl esters, afterwards spraying with ferric chloride to ascertain the positions of the salts.

We find that the volatility of the acids can be more easily overcome by conversion into the corresponding sodium salts and separation of the anions with butanol saturated with $1 \cdot 5\,N$ ammonium hydroxide. After drying at 95° C. for five minutes, the paper is sprayed with a suitable indicator solution. Preliminary work has shown that Bromocresol Green (40 mgm. in 100 ml. of water or alcohol, adjusted to blue with sodium hydroxide) reveals the anions as yellow spots and the cations as deep blue spots on a pale blue background. Bromothymol Blue (40 mgm. in 100 ml. water adjusted to blue with sodium hydroxide) gives rise to yellow spots at the positions of the anions and deep blue spots at the positions of the cations on a green background.

r_f VALUES OF CARBOXYLATE IONS IN BUTANOL–1·5 *N* AMMONIUM HYDROXIDE AT 15° C. WHATMAN NO. 1 PAPERS. 1 PER CENT SOLUTIONS

Anion	r_f	Anion	r_f
Formate	0·09	Salicylate	0·50
Acetate	0·10	*β*-Phenylpropionate	0·52
Propionate	0·19	Lactate	0·07
n-Butyrate	0·33	Oxalate	0
n-Valerate	0·45	Malate	0
n-Caproate	0·61	Tartrate	0
n-Caprylate	0·74	Adipate	0
Benzoate	0·39	Citrate	0

The r_f values of the anions of the lower fatty acids are shown in the accompanying table. Formate and acetate have similar r_f values; but confusion between the two can be avoided by making use of the reaction between the former and ammoniacal silver nitrate. The other anions of the series give well-separated spots.

The r_f values of several other carboxylate ions are also included in the table. It is interesting to note that dicarboxylate ions do not move from the starting line in the solvent used. The method appears to be applicable to the sodium salts of both aromatic and aliphatic monocarboxylic acids, although these could probably be more conveniently separated as the free acids.

The cations (in this case the sodium ion) moved only short distances from the starting line. An interesting feature was, however, the increase in excursion of the cation as the r_f value of the anion increased. Full experimental details will be published elsewhere.

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Hydrolysis of Laminarin by Wheat β-Amylase

THE only enzymes so far found to hydrolyse laminarin are those of the snail[1] and the limpet[2]. In 1915 Kylin[3] stated that he had hydrolysed it with malt diastase; but he has recently withdrawn this claim[4], and in this Laboratory also it has been found that malt diastase is without action on laminarin.

We have now found that the β-amylase of wheat hydrolyses laminarin, yielding glucose (70 per cent) and a disaccharide. The rate of hydrolysis is slow. An extract of the enzyme which hydrolysed starch in a few hours took several days to hydrolyse laminarin. Since malt diastase is inactive, the action must be due to some factor other than the small amount of α-amylase in the wheat enzyme.

This ability of wheat β-amylase to hydrolyse 1 : 3 linkages is of interest in connexion with recent work on the action of amylases on starch. Thus, Barry, Halsall, Hirst and Jones[5] found that crystalline β-amylase had little effect on floridean starch, whereas we have found that wheat β-amylase hydrolyses it to maltose to the extent of 50 per cent. Again, Halsall, Hirst, Hough and Jones[6] found that the limit dextrins produced from amylopectins by crystalline β-amylase have a much higher molecular weight than those from the crude wheat enzyme. These facts suggest that the amylopectins contain 1 : 3 linkages which are hydrolysed by the factor in wheat β-amylase that hydrolyses laminarin. The occurrence of such linkages in glycogen has already been suggested by Bell[7].

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Separation of *Nor*Adrenalin and Adrenalin

A METHOD of separating these two substances on paper chromatograms, using phenol as solvent, has been described earlier[1]. No satisfactory second solvent, enabling a two-way chromatogram to be performed, was found at the time, and it was necessary to use the substances as hydrochlorides, the free bases being insufficiently stable. Movement in *n*-butanol was very slight. More recently, von Euler and Hamberg[2] have reported separation of adrenalin and *l*-*nor*-adrenalin, using *n*-butanol saturated with *N* hydrochloric acid. Their results are recorded in a photograph of a small part of the chromatogram and no data are given for the r_f values or the time necessary to obtain separation. On repeating their experiment, we found that movement was very little greater than in our original *n*-butanol – water system, and that, to obtain separation, the chromatogram had to be run for forty-eight hours or longer, allowing the solvent to drip from the end of the paper. It was, therefore, not possible to determine r_f values.

It appeared probable that greater travel, allowing a faster separation, might be obtained by using an organic acid instead of hydrochloric acid. Acetic and trichloracetic acids were chosen for trial. For experiments with the first, the bases were applied as solutions in 5 per cent acetic acid, and the solvent was an *n*-butanol – acetic acid mixture made by shaking four parts *n*-butanol with one part glacial acetic acid and five parts water, and rejecting the lower layer on separation. For trichloracetic acid experiments, a 5 per cent solution was used to dissolve the bases, and the solvent was made up with 5 gm. trichloracetic acid dissolved in 100 ml. water and added to 80 ml. *n*-butanol. After shaking, the lower layer was discarded. 0·015 ml. solution containing about 0·03 mgm. adrenalin or *nor*adrenalin was applied with an 'Agla' pipette and the run made in a saturated atmosphere over the appropriate mixture.

Drying the papers in gentle heat did not drive off all the acid, and more alkali was needed in the indicator than was used previously. 0·44 per cent potassium ferricyanide was dissolved in $M/5$ sodium phosphate (Sörensen salt) to give pH 8·3. As a further precaution when using trichloracetic acid, the strips were held over the mouth of a bottle containing 0·880 ammonia, and this sometimes strengthened the reaction. The colours given were pink with adrenalin and mauve with *nor*adrenalin. The following results were obtained :

Substance		Solvent	r_f
*Nor*adrenalin	(hydrochloric)	Butanol-hydrochloric	0·09
,,	(acetic)	Butanol-acetic	0·25
,,	(trichloracetic)	Butanol-trichloracetic	0·33
Adrenalin	(hydrochloric)	Butanol-hydrochloric	0·10
,,	(acetic)	Butanol-acetic	0·31
,,	(trichloracetic)	Butanol-trichloracetic	0·45
Methyladrenalin	(acetic)	Butanol-acetic	0·31

None of the separations was as good as with phenol; but after twenty-two hours with acetic or trichloracetic acid the adrenalin and *nor*adrenalin spots had always separated completely. The r_f values remained the same whether the bases were applied separately or in mixture. Methyladrenalin had an r_f indistinguishable from adrenalin and could not be separated in these solvents. Although the greatest difference between the r_f's is obtained by using trichloracetic acid, the advantage is reduced by a somewhat greater spreading of the spots.

We have made the separation of the acetates in butanol - acetic the basis of a quantitative estimation of adrenalin and *nor*adrenalin in mixtures. The details of the method are being published elsewhere.

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Positive Bromine Ions

Recently, several authors have postulated the existence of positive monovalent bromine ions on purely theoretical grounds[1,2], or in order to explain the fact that hypobromous acid (HOBr) acts as a powerful brominating agent in strongly acid solutions[3]. This latter mechanism of substitution is very similar to that of nitration in strong sulphuric acid solution as suggested by several investigators[4-6]. Pyridine complexes of positive iodine and bromine ions have been prepared by the reaction of the halogen with silver nitrate in organic solvents[7,8].

We introduced a 4 per cent solution of hypobromous acid into the middle chamber of a tripartite electrolytic apparatus and filled the electrode compartments with a 1/100 molar solution of sodium fluorescein. Sodium sulphate was added to the latter to increase their conductivity. Thus both Br^+ and OBr^- ions were trapped in the form of eosin immediately after having crossed their respective membranes. We used membranes of collodion-impregnated blotting paper. Their preparation as well as the instability of the hypobromous acid solutions were the cause of most trouble in our experiments.

Even without any current passing through the chamber, there is always a certain amount of diffusion across the membranes, so that it is only a question of time before the eosin colour appears in the electrode chambers. Any effect produced by electrodialysis must be significantly greater than this diffusion; therefore we always began a series on a pair of membranes with a diffusion experiment, then changed the solutions in the apparatus, carried out an electrodialytic experiment, which was followed, again after changing the solutions, by a second diffusion control. The electrodialytic effect began slowly as the first ions crossed the membranes; it was visible after about fifteen minutes.

Table 1

Time (min.)	Percentage of eosin		
	1st diffusion	Electrodialysis	2nd diffusion
15	0	< 5	0
30	0	~10	0
45	0	~30	~3
60	~2	~50	~4
75	–	—	< 5

The results of such an experiment are shown in Table 1. The hypobromous acid solution was acidified in this experiment with about 7 per cent sulphuric acid. In order to express the successive colours of samples withdrawn from the electrode chambers by numbers, we compared them with a series of mixtures of sodium fluorescein and sodium eosin ($M/100$). The numbers given in Table 1 are only approximate; but the existence of the positive bromine ion effect is quite beyond the limits of error. The current was about 0·5 amp. during most experiments.

The acidity which developed spontaneously by decomposition of the hypobromous acid was sufficient to give similar results in other experiments.

If, however, the middle compartment was made alkaline, eosin was produced only at the anodic side of the apparatus. It was necessary to keep the anode chamber alkaline during electrolysis, otherwise fluorescein was precipitated. An experiment with alkaline OBr^- solution followed by another one with acid HOBr solution is summed up in Table 2.

Table 2

Time (min.)	Percentage of eosin			
	Alkaline OBr^-		Acid HOBr	
	Cathode	Anode	Cathode	Anode
15	0	~ 5	~ 4	~3
30	0	~30	~15	~4
45	0	~50	~20	~5
60	~3	~75	~30	~9

It is interesting that, whereas practically all OBr^- ions tend towards the anode in alkaline solution, the greater part of the hypobromous acid goes towards the cathode if the solution is acidified. These experiments prove decisively that the postulated positive bromine ions really exist in acid solutions of hypobromous acid. We propose calling this new ion the *bromo*-ion, and accordingly we can give the amphoteric partner of hypobromous acid (HOBr) the name bromo-hydroxide (Br.OH).

Similar experiments with solutions of hypochlorous acid were negative, using an acidified dilute methyl orange solution as bleaching indicator. This result is in agreement with the strongly electro-negative character of chlorine.

Neither were we able, contrary to chemical expectation, to establish the existence of positive iodine ions in acid, aqueous solutions. The indicator used was sodium fluorescein. We think that our failure is due to the very rapid disproportionation of the IOH molecule.

A detailed account of our experiments will appear in *Magyar Kémiai Folyóirat*. One of us (F. K.) is indebted to the Hungarian Academy of Science for a grant.

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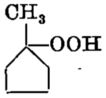
Reaction of Methylcyclo*alkyl Hydroperoxides with Ferrous Sulphate

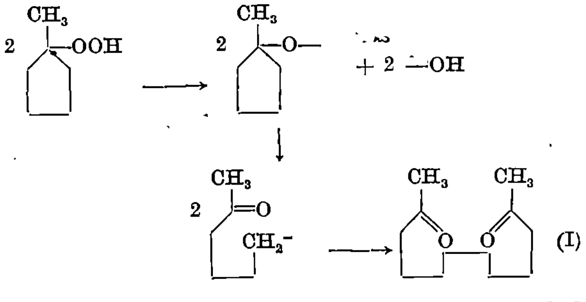
It has been found that when methyl*cyclo*pentyl hydroperoxide,



obtained from the oxidation products of the hydrocarbon[1], is treated with ferrous sulphate solution, the major product (*c.* 50 per cent) is a white solid of melting point 67·5–68·5° (I).

Analysis of this solid corresponds to the molecular formula $C_{12}H_{22}O_2$, and it has been identified as dodecanedione-2 : 11 [2,3] by the following evidence: (i) oxidation with sodium hypobromite yielded sebacic acid; (ii) treatment with methyl magnesium iodide provided the dicarbinol 2 : 11-dimethyldodecanediol-2 : 11, $C_{14}H_{32}O_2$ (m.p. 57–58·5°), identical with that formed from dimethyl sebacate by reaction with methyl magnesium iodide; (iii) reduction of the hydrazone by the Wolff–Kishner method[4] gave *n*-dodecane, identified by its infra-red spectrum; (iv) dodecanedione-2 : 11 was afterwards synthesized by Dr. D. P. Young in these laboratories by reaction of dimethyl cadmium with sebacoyl chloride, and proved to be identical with the product derived from the hydroperoxide decomposition.

The reaction proceeds very rapidly and evidently involves the dimerization of a free radical:



The other products of the reaction include methyl butyl ketone and carbinols.

Methyl*cyclo*hexyl hydroperoxide, on the other hand, reacts much more slowly with ferrous sulphate solution, and the yield of the corresponding tetradecanedione-2 : 13 (m.p. 76–77° [5]) is quite small (*c.* 10 per cent); the monoketones (including methyl amyl ketone) and alcohols are the main constituents of the product.

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Anomalous Thermal Expansion of the Short Intermolecular Bond in *para*-Nitro-aniline

A recent determination of the detailed crystal structure of *para*-nitro-aniline has revealed an unusually short distance of approach (2·66 A.) between the oxygen atom of an NO_2 group of one molecule and one of the carbon atoms of the aromatic nucleus on a proximate molecule[1]. This suggests special forces between these two atoms, the attraction of which appears to be intermediate between that in a covalent bond, and that due solely to Van der Waals' forces, and may be electrostatic in origin.

In analogous cases where special forces may contribute to the attraction, in short hydrogen bonds, anomalous thermal expansion of the bond has been observed in all the cases so far investigated[2-6]. This can be explained on the basis of exceptionally high anharmonicity of vibrations of such 'bonds'[2,7]. Measurements of thermal expansion of *para*-nitro-aniline have now been carried out and have shown a similar anomaly.

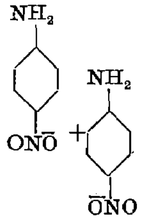
The expansion ellipsoid for the total contraction over the temperature-range 288–90° K. has the axes $\alpha_{11} = 2 \cdot 95 \times 10^{-2}$ at 55° to the *c* axis, α_{22} (along *b* axis, by crystal symmetry) $= 0 \cdot 24 \times 10^{-2}$, $\alpha_{33} = 0 \cdot 45 \times 10^{-2}$.

This very large contraction along the α_{11} axis of the expansion ellipsoid coincides within 11° with the direction of the 'short intermolecular bond'. If the whole of the contraction on cooling were attributed solely to this bond, the short intermolecular bond would have a length of 2·46 A. at 90° K. This gives an extreme value. Even if only the excess contraction over the average along the three axes is attributed to the bond, the length at 90° K. would be 2·53 A.

This observation suggests a number of most interesting possibilities which are being further investigated.

(i) If the contraction maintains its anomalously large value along the bond direction below 90° K., the length of the short intermolecular bond at 0° K. must approximate to what might be expected for *ionic* contact, for example, as in the diagram (p. 70).

From the structure of sodium and potassium nitrites[8], the ionic contact radius attributable to the oxygen atoms of O—N—O in the nitrite ion can be computed to be approximately 1·45 A. Since the length of the short intermolecular bond at 0° K. must be less than 2·53 A., this would leave a contact radius less than (2·53–1·45) A., that is, less than 1·08 A. for the positive carbonium ion. Such a value



The molecules have been rotated to lie in the plane of the paper

is not unreasonable, compared with $r_{Na^+} = 0\cdot98$ A. and $r_{NH_4^+} = 1\cdot48$ A.

(ii) If the molecules in the crystal really transfer electrons in this way, the extent of the transfer must be strongly linked with the precise lattice dimensions and must be sensitive to various factors such as pressure or thermal expansion. The case would be analogous with the sensitiveness of proton position to bond-length in Rochelle salt[5,7], and interesting electrical properties may be anticipated in the direction in which the bonds lie in the crystal. These are being investigated.

(iii) Although the above suggestion about the nature of the forces responsible for the short intermolecular bond in *para*-nitro-aniline can only be put forward tentatively, the change from more or less complete electron transfer at low temperatures and close distances of approach to strong polarization with less and less complete transfer as the bond lengthens would present an extreme case of the donor bond originating from the aromatic nucleus, in compounds such as $I_2.C_6H_6$ [9], $WCl_6.C_6H_6$ [10], and the polarization bond in various complexes between nitro groups and aromatic hydrocarbons[11,1].

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A Characteristic Example of Re-trapping in Phosphorescence

THERE has been much discussion about the existence of re-trapping (electronic recapture) in phosphorescence[1]. One of my experiments seems to demonstrate the existence of re-trapping: electrons leave the deep traps and get into the short-life traps. I used a calcium sulphide (bismuth activator) phosphor of very long afterglow. This sulphide was strongly excited by ultra-violet radiations of about $0\cdot36\,\mu$ from a mercury vapour arc; it was then heated up to 135° C. until complete extinction was reached. When the sulphide had cooled down to room temperature, it was submitted to the infra-red radiations of a 300-W. electric lamp filtered by a black manganese–iron glass with transparent range of $0\cdot8\,\mu$–$4\,\mu$ with some peaks between $1\,\mu$ and $4\,\mu$.

Stimulated by these infra-red radiations, the sulphide regains its emitting power. After a few seconds, its glow reaches a nearly constant value; and if the infra-red lamp is stopped, an afterglow is observed during a few minutes, the rate of decrease of this afterglow against time being given by the following figures:

	Under infra-red light	After 10 s.	20 s.	30 s.	40 s.	50 s.	60 s.	120 s.
Intensity (arbitrary units)	16	0·50	0·40	0·32	0·25	0·19	0·15	0·12

The phenomenon can be explained as follows: the heated sulphide still contains, trapped in deep traps, some electrons[2] which are slowly liberated by the infra-red radiations, thus producing an emission of visible light; but many of the electrons fall into short-life traps, whence they are emitted during a few minutes after the infra-red light has ceased, producing thus the afterglow.

I ascertained that the black filter allows no radiatoni having direct exciting power to pass by testing the action of the filtered radiation on various organic fluorescent powders. Further, if the infra-red radiation is allowed to act for an hour, the glow of the calcium sulphide phosphor is totally quenched. If, instead of putting the cooled phosphor under the infra-red lamp, it was heated quickly again at 135° C., no emission was observed. Consequently, the short-lived phosphorescence described above cannot be ascribed to the heat generated in the sulphide by the infra-red light. Experiments made with some zinc sulphides gave similar results.

Note added in proof. I have just learned of a recent paper by Garlick and Mason[3], in which they also describe experimental evidence of retrapping.

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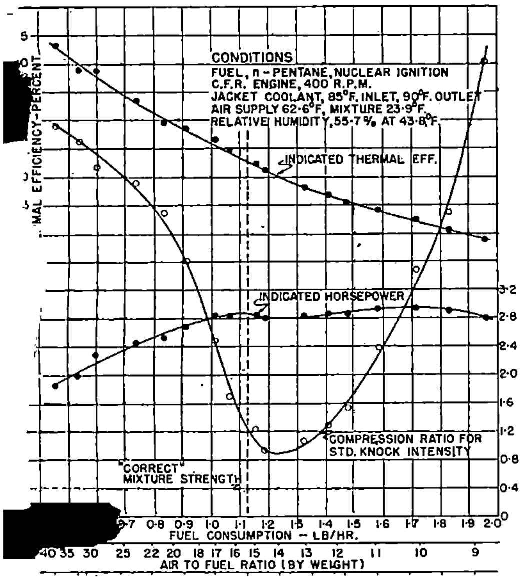
Exceptional Performance of a Nuclear Ignition Otto-cycle Engine using *n*-Pentane as Fuel

KNOCKING combustion (detonation) in Otto-cycle engines using hydrocarbon fuel is attributed by King[1] to the effect of finely divided carbon in igniting the unburned combustible mixture ahead of the flame front (the end gas). The carbon particles can, according to this view, be provided (*a*) by pyrolysis of the hydrocarbon at the high pressure and temperature attained by the end gas, or (*b*) by impingement of the flame on relatively cool surfaces in the combustion space, as in a method commonly used for procuring carbon black.

sual temperature conditions of engine opera- cially those of the C.F.R.–A.S.T.M. knock- cedure, are such that finely divided carbon ed after spark ignition by method (*a*). It ble, however, to provide low surface-tempera- onditions in which the carbon is obtained by od (*b*) and appears in the combustion space in orm of lamp black. Recent experiments made dingly have yielded the somewhat remarkable s shown by the graphs accompanying this . It will be seen by reference to the graphs it was possible to use a mixture 60 per cent ; the indicated thermal efficiency being then er cent at a usable compression ratio of 11·5 : 1, is, 85 per cent of the air-standard value. The mum thermal efficiency previously recorded is, as known, that of 51·6 per cent or 79 per cent e air-standard value, obtained by Ricardo for ak mixture used in a Diesel engine at 15 : 1 ression ratio.



thermal efficiency was 40 per cent at a usable ession ratio of 10 : 1 and a mixture strength cent weak, which in usual conditions is the t practicable. At the 'correct' mixture, l efficiency was 32·5 per cent and the usable ssion ratio 7·2 : 1, an unusually high value engine speed of 400 r.p.m. The minimum of 6·9 for the usable compression ratio was d for a mixture 9 per cent rich. The value se with further increase of mixture strength, ng 12·4 : 1 for a mixture 75 per cent rich. A m power output was obtained for the correct , and a second but slightly higher maximum ixture 40 per cent rich. Power output varied oximately 5 per cent only over the mixture 0 per cent weak to 65 per cent rich.

d' values mentioned above were obtained gnition. The experiments appear to in respect of (*a*) the mechanism all types of internal combustion mechanism of detonation, whether in engines. The experiments will discussed elsewhere in greater

The experiments were made in the Department of Mechanical Engineering, University of Toronto, with the co-operation of Prof. E. A. Allcutt, head of the Department.

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Defence Research Board, Ottawa.
E. J. Durand
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Department of Mechanical Engineering,
University of Toronto. Feb. 21.

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[1] King, R. O., *Can. J. Research*, F, 26, 228 (1948).

The Reticulo-Spinal Apparatus and Rigidity

It is commonly held that the vestibulo-spinal apparatus is responsible for maintaining the spastic condition which occurs after decerebration and other operations. Recently, Schreiner, Lindsley and Magoun[1] and others have suggested that the reticulo-spinal mechanism is more likely to be implicated. In this connexion the following observations upon an anuran, *Bufo marinus*, are of interest.

It has been shown[2] that symmetrical rigidity can be produced in these animals by damage to the mid-brain, cerebellectomy, bilateral removal of the eighth nerves or the octavo-lateral areas, or by coronal or sagittal section in the anterior medulla oblongata—especially at the level of octavus entrance. The rigidity can be maintained indefinitely after removal of midbrain, cerebellum, both eighth nerves and both octavo-lateral areas. After such operation the residual stump of medulla contains, apart from the usual motor nuclei, little more than a continuous column of small cells. There appears to be no mechanism by which vestibular impulses can play any part, yet the rigidity is maintained.

The continuous column of small cells extends throughout the central nervous system. In the medulla and cord it is intimately associated with the motor cells. In the cord the cells occupy the position described by Brooks and Eccles[3] for their Golgi type II cells. In the medulla the column occupies the position of the nucleus intercalatus of Staderini and the medial vestibular nucleus, and is giving rise to a superior olive. Throughout, there are numerous longitudinal and crossed connexions. The bulbo-spinal part of the total system appears to correspond to the reticulo-spinal system of mammals, and is considered the source of the impulses which preserve rigidity.

Anatomical observations point to the probability that the reticulo-spinal apparatus is a ventral, or basal laminar, derivative of a general intercalator system, concerned primarily with motor co-ordination at a segmental level, but under the dominance of suprasegmental systems. Histological appearances strongly suggest that the intercalator apparatus serves as a co-ordinating intermediary between all afferent systems on one hand and the motor cells on the other. If so, it serves all the functions commonly ascribed to the motoneuron pool. It would appear appropriate to substitute for this term that of 'reticulo-motor pool'.

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---

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Insecticidal Action of Radioactive *bis*-(*bis*-Dimethylamino)-Phosphonous Anhydride

THE preparation of *bis*-(*bis*-dimethylamino)-phosphonous anhydride containing phosphorus-32 has been reported[1], and a detailed description of the methods employed is now in the press[2]. I am indebted to the authors of the above-mentioned papers, Dr. B. A. Kilby and Mr. J. E. Gardiner, for the supplies of the radio-anhydride used in the present investigation.

The plants and insects used were chiefly broad beans infested with *Aphis fabæ*, Scop.; but some young cabbages infested with *Myzus persicæ*, Sul., young peas with *Acyrthosiphum onobrychidis*, Fons. and uninfested strawberry plants and newly sprouted hop sets were also employed. The plants were kept in a greenhouse at about 15–25° C. while being treated with the radio-anhydride[3]. The activity of the solution used was never more than the equivalent of about 10 microcuries per litre.

The assays of radioactivity were made in a liquid-type counter after treating the plant material with boiling caustic soda solution. In most of the assays no attempt was made to determine how much of the radioactivity was from unchanged anhydride in the plant and how much was from decomposition products.

Absorption from culture solution. A few hours after a bean plant is placed in a culture solution containing the anhydride, radioactivity can be detected in the leaves, and shortly afterwards the aphids on the plants begin to fall off. The level of activity increases as the culture solution is absorbed and is always higher in the washed roots than in the aerial parts of the plant. As the plant absorbs the culture solution, the radioactivity of the remaining solution is found to increase, showing that the roots selectively reject the radio-anhydride.

Absorption from sand and soil. It appears that bean plants can absorb the radio-anhydride more rapidly from sand than from soil. Thus plants growing in sand become radioactive sooner, reach a higher level of activity and loose their aphids earlier than similarly treated plants in soil.

The radioactivity of all the leaves on a bean plant growing in treated sand or soil is not the same. The bottom (oldest) leaf and the top (youngest) leaf show less radioactivity per gram of tissue than leaves from the middle part of the stem.

Concentration in the plant necessary to kill aphids. If it is assumed that the material soluble in chloroform, which can be extracted from the plant after boiling with water and treating with caustic soda under controlled conditions[4], is the unchanged anhydride, it can be calculated that, at a time when the plants are lethal to aphids, about 100 mgm. of anhydride per kilo of plant tissue is present. This value agrees well with that of 60–100 mgm./kilo given previously[3].

Absorption and translocation following application to the leaves. When the leaves of certain plants are treated repeatedly with a 0·1 per cent v/v solution of the anhydride containing radio-anhydride, other leaves on the plant besides those treated become radioactive. It has previously been reported that aphids are killed as a result of the systemic translocation of the anhydride in this way[5], but that the effect could not be shown with the broad bean[3]. By means of the radio-anhydride, it has now been possible to show that there is some translocation in the broad bean; but the level of radioactivity reacl
untreated leaves is relatively low, and
feeding on them are not killed.

In contrast to the above observation
bean, there is much more translocation
cabbage and pea plants, and the leaves atta
higher level of radioactivity and the aphid
are killed. Translocation to untreated le
occurs to a marked extent in actively gro
and strawberry plants.

The strawberry, as Dr. G. H. L. Dicker h
provides an interesting demonstration of t
location of the anhydride within the plan
an application made only to the leaves of t
plant, the leaves of the runners become
aphids[6]. This experiment has been repea
the radio-anhydride, and it has been fou
radioactive material passes from the leave
parent plant to those of the runner, especia
the runner is not rooted in soil.

The observations just described show th
radioactive *bis*-(*bis*-dimethylamino)-phospho
hydride is applied to the leaves of a plant, son
active material, probably the anhydride i
absorbed by them and afterwards translocate
the plant. Most of the experiments were pla
show the transference of material from th
leaves to the younger parts of growing plants
is, however, similar, but less complete, evid
the time of writing that the radioactive co
is translocated downwards from the leaves
upper or the middle section of the plant to th
leaves.

Further experiments will be necessary to e
under what conditions insecticidal quantities c
is supposed to be anhydride are translocated
treated to untreated leaves.

Examination of transpired material. Experi
failed to show that any radioactive material is
off by the plants absorbing the radio-anhydri
the roots.

Examination of aphids and honey dew.
which were killed by feeding on pla
the radio-anhydride, and also the honey
they produced, were found to be radioactive.

W. A. L. DA

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April 4.

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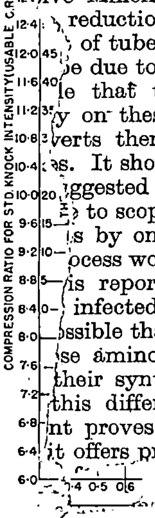
Effect of Leaf Roll Virus on the Am Acid Composition of Potato Tube

THE paper chromatographic method of V
and Kirby[1] has been applied to extract
tubers in order to study the effect of
on their amino-acid content. Ext
and leaf roll tubers (Green Mount
prepared either according to the
et al.[2] using 70 per cent alcohol,
of lead acetate to aqueous extra
precipitation was attained.

The u tograms of twenty-eight healthy and
tion, espe ht leaf-roll infected tubers revealed a
rating pr d consistent difference in the occurrence
is obtair phane and tyrosine. In chromatograms of
is possi tubers, both these amino-acids were invariably
ture c in appreciable amounts, while in those of
meth d tubers no tryptophane and very little or no
the ine was observed. This was found with
accor us as well as alcoholic extracts. Three standard
result cal tests for tryptophane and tyrosine were
lette applied to extracts of a further twenty-five
that hy and twenty-five leaf-roll infected tubers: the
we aldehyde test for tryptophane[3], Millon's test for
53 ine[3], and Folin's test for phenolic hydroxyl
that pounds as in tryptophane and tyrosine[3].
max diseased tubers gave a negative benzaldehyde
so fa nd a faintly positive Millon's and Folin's test.
of t the healthy tubers the following results were
a w ned: benzaldehyde test, 22 positive, 3 negative;
com n's test, 21 positive, 4 faintly positive; Folin's
24 positive, 1 faintly positive. The four tubers
gave the negative benzaldehyde test gave
ive Millon's and Folin's reactions.



reduction in the tryptophane- and tyrosine-
of tubers on infection with the leaf roll virus
e due to any one of a number of causes. It is
le that the virus molecule draws especially
y on these two amino-acids for its formation,
verts them into the production of other sub-
s. It should be noted in this respect that Best[4]
ggested a pathway for the conversion of
to scopoletin, a substance found in abnormal
s by one of us[5,6] in leaf-roll infected plants.
ocess would require the presence of tyrosinase,
is reported to be slightly more active in
infected tubers than in healthy ones[7]. It is
ssible that, instead of hastening the utilization
se amino-acids, the leaf roll virus interferes
their synthesis.
this difference in tryptophane- and tyrosine-
nt proves to be specific for leaf-roll infection,
it offers promise of becoming the basis of a long
le, chemical test for the diagnosis of
tubors.

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maxim
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iations in *Aulacorthum solani* Kalt.

by app
range Irish material of *Aulacorthum solani* Kalt.
The rec a—Aphididæ) sent in for identification to
without spark eum (Natural History) in 1939 showed
be of significanc the typical form. Progeny from the
of combustion in ted showed marked variation. In
engines and (*b*) the e apterous viviparous female was
it occur in tubes o e two quite different larvæ, which
be described and ed into forms exhibiting accent-
detail. tion.

From these observations followed a series of breeding experiments to determine the full series of variations and some food-plant preferences, including the part played by weeds of cultivated land in carrying over the species from one year to the next. These experiments extended from 1939 to 1942.

Further experiments during 1947 and 1948, and at present in progress in a heated insectary, repeat parts of the previous series. Approximately 1,500 specimens were examined and measured in the earlier experiments. Apteræ varied to the extent that they could be classified, on the basis of size, colour and principal morphological features, into three main types of large apteræ and one of dwarf apteræ, the latter showing some thirteen subsidiary variants. The alate viviparous females fell into two types of large alatæ and three types of dwarf alatæ, besides individuals intermediate between these types and between apteræ and alatæ. The dwarf alatæ, in particular, showed very marked differences in antennal measurements, distribution of rhinaria, form and pigmentation of cornicles and cauda, and abdominal ornamentation.

The existence of the several intermediates suggests that they are, in fact, variants of a single species, and that the original clone did not later become mixed with contaminants introduced accidentally with food-plants; indeed, precautions against this were specially taken.

Parallel experiments to the above were carried out on *Aulacorthum circumflexus* Buckton. The recent series of experiments on both species have made use of material from several parts of Eire as well as several localities in England. Critical tests to determine the degree to which these two species are related will be undertaken.

The question of the variations in *Aulacorthum solani* Kalt. and *A. circumflexus* Buckt. under both natural and artificial conditions, together with a discussion of the systematic position of both species, will form the subject of a further publication elsewhere. Full descriptions of the morphological characters of all forms will be included.

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Longevity in the Grey Seal

HAVING had occasion recently to consult the late Major S. S. Flower's paper[1] on the duration of life among mammals, I notice that data regarding the Phocidæ (apart from *Phoca vitulina*) are extremely scanty. The only information given about the grey seal, *Halichœrus grypus*, is that one (sex unspecified) "is known to have lived for a very long time in an underground tank in the old Berlin Aquarium; it died about 1906, after, I was told, eighteen years in the Aquarium. . . . In Lincoln's Inn Fields, in the Museum of the Royal College of Surgeons, is the skull, and imperfect skeleton, of an aged Grey Seal . . . from the original Hunterian collection, which was 'stated to have been presented to Mr. Hunter by a Mr. Oxendon, probably the gentleman who went for two years in succession to the Orkney Isles for the purpose of shooting it. This animal had been known for thirty summers to come to the same rock, and lie basking in the sun.' "

It may be useful, therefore, to record a grey seal (a female) which was taken some time in 1912 (I believe as a pup) and placed in a pond in Victoria Park, Cardiff, where it lived until April 6, 1939. This animal, therefore, lived more than 26 years 3 months in captivity. The mounted skeleton (accession number 39.211) is preserved in the Zoology Department of the National Museum of Wales. Dr. Edward Hindle has been good enough to direct my attention to another grey seal, in the Stockholm Zoo at Skansen, recorded in 1935 by Dr. Erna Mohr[2], the animal being then at least thirty-six years old. Capt. Gustaf Lilliehöök, acting director of the Zoological Department of Skansen, has written to me that this seal "was caught, aged a few months, in the spring of 1898 or 1899, near the town of Uddevalla on the west coast of Sweden", and soon afterwards "was sent to Skansen, where he lived . . . till March, 1940, when he was found one day lying dead at the bottom of his pond". This grey seal, therefore, apparently reached the record age of forty-one or possibly forty-two years.

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---

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Influence of Pregnancy and Social Facilitation on the Behaviour of the Grazing Sheep

BAYER[1] has shown that the presence of a hungry hen can increase the food consumption of a well-fed hen by as much as 60 per cent. This social facilitation has also been observed in fish[2], rats[3] and apes[4]. It is now reported in grazing sheep.

A flock of fifty Blackface ewes was divided into two groups of twenty-five as nearly equal as possible in weight and general condition. Every animal in group *A* was offered one pound of the following ration daily: 2 parts linseed cake meal, and 1 part crushed oats. Group *B* received no supplement. The management of the flock, which was also used in studies on worm-burden and immunity, was described by Cushnie and White[5]. For lambing in March–April 1948, the two groups were first enclosed separately in neighbouring fields of comparable size and botanical composition. Observations, each lasting for a continuous period of twenty-four hours, were made on the behaviour of ten sheep in each group. Group *B* was then put into the same field as group *A*, and further observations were made on the behaviour of three more animals from each group.

Before differences in the behaviour of the two groups can be discussed, however, a further point must be considered. These observations were all made when the sheep were in the last stages of pregnancy, and it was therefore necessary to determine whether this condition by itself influenced the times spent grazing. Of the ten sheep in each group that were watched in the first series of observations, five were carrying twins and five singletons, and, of the three sheep in each group that were watched in the second series of observations, one carried twins and two singletons. The results may be summarized as follows:

(*a*) When the two groups grazed separately, the supplemented group spent less time grazing and more time resting than the unsupplemented group.

(*b*) When the two groups grazed together, their grazing and resting times were very similar and represented those of the unsupplemented group when grazed alone.

(*c*) Ewes of the supplemented group which carried twins grazed for approximately one hour longer than those of the same group that carried singletons.

(*d*) There was no difference in the grazing times of ewes of the unsupplemented group which carried twins and those of the same group which carried singletons.

That there was a difference of approximately one hour in the grazing-times of the ewes that carried twins and those with singletons in the supplemented group, whereas the times devoted to grazing by all those in the unsupplemented group were the same, suggests that a fatigue-limit influenced the behaviour of the latter group. It may be that after approximately eleven or twelve hours out of twenty-four has been spent grazing, the animal generally, and particularly the musculature of the jaw, is too fatigued to continue.

It is clear that in addition to the social conditions of the environment, the times devoted to grazing may be greatly influenced by pregnancy.

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Life-history of the European Earwig, *Forficula auricularia*

WORKERS in Europe[1-4] have maintained that the common earwig, *Forficula auricularia* L., is single-brooded in Europe, whereas American researchers[5-9] have recorded that this species in America has two broods a year. Recently, Bolwig[10] reported from Denmark that *F. auricularia* is single-brooded, and laid a second batch only if the first eggs were destroyed. However, while studying the life-history of *F. auricularia* in the Department of Zoology, University of Edinburgh, I found the earwig to be double-brooded. The first or winter batch of eggs is laid between late November and March. During May–June some of the females die, and the others lay a second or spring batch of eggs. A detailed account of the investigations will appear elsewhere.

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Phalaropes in Central Borneo

LITTLE is known of the movements of the northern phalarope (*Phalaropus lobatus* L.) which winters in large numbers in the seas south of Borneo. None has been recorded for Malaya, and until recently it was not known from Borneo itself.

In 1945–49, I found it an abundant passage migrant on the upland area of the far interior, inhabited by the Kelabits between 3,000 and 4,000 ft.[1]. The earliest arrival was October 10, the latest November 5 (1949). The birds, in full winter plumage, are so tame that they sit in the irrigated rice plots and allow themselves to be picked off by small boys using the 6-ft. blowpipes with which Kelabits are most expert.

Three specimens have also been taken farther south in the interior, all in October or November, one in a little stream on Mt. Dulit at 4,000 ft. In October 1945, I nearly touched another with a paddle while canoeing down the Baram River in central Dutch Borneo, at about 2,000 ft.

None is known from the lowlands.

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South Pacific Chlorophyceæ

A REVISION of the marine Myxophyceæ of New Zealand has resulted in the addition of many species, none new, to the flora. A similar revision of the Chlorophyceæ has revealed the fact that even in this well-known group the flora of the South Pacific is probably the most profitable field for phycologists. The new discoveries include a new genus of the Ulvales with five species, three of which are restricted to Stewart Island and the southern Antarctic dependencies. In this remarkable new genus the cells, which are small in surface view, are commonly in pairs (hence it is proposed to call the genus *Gemina*) and are excessively elongated vertically. They are also extruded very readily from the matrix of the lamina. The other interesting feature is the manner in which the species simulate other genera of the Ulvales. Thus one species has the appearance of an *Enteromorpha*, two have the appearance respectively of orbicular and lanceolate species of *Ulva* and a fourth is like a *Letterstedtia*.

The genus *Ulva* has also proved a rich source of new species, in many cases differing markedly from existing species. Cultural studies of two of the new species may result in their transfer to a new genus, because herbarium material suggests that the reproductive cells differ from the vegetative cells and are restricted to the centre portion of the thallus. In gross appearance these two species are not unlike *U. linza* and *U. tœniata*. Other genera rich in new species are *Monostroma*, *Chœtomorpha* and *Rhizoclonium*, the latter being very interesting in possessing one species at least that might almost be mistaken for a *Cladophora*.

The genus *Bryopsis* is also very rich in new species, so much so that one must suspect that either active evolution is progressing in these waters or else that the genus originated in the South Pacific. The new species have only been created after comparison with material of the other known species, in which connexion thanks are due to Profs. Papenfuss and Mason of the University of California for loan of material.

It is hoped to publish the sections dealing with the Myxophyceæ and Chlorophyceæ (including all the new species) this year. The revision has been facilitated by access to the Laing collection (kindly loaned by Canterbury College), the collection of the Plant Research Bureau and the private collection of Mr. V. W. Lindauer.

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Effect of Sowing Time and Photoperiods in *Sorghum Roxburghii* var. *hians*, Stapf. (Jowar)

SEEDS of *Sorghum Roxburghii* var. *hians* were sown for one year at intervals of one month commencing February 15, 1949. Owing to a limited number of available seeds, about twenty seeds were sown in single small plots (5 ft. × 3 ft.). Although there was a good percentage of germination in all the sowings except those of November 15, 1949, December 15, 1949, and January 15, 1950, only a limited number of plants varying between three and nine for the different sowings survived until the flowering stage. The date of first emergence of the panicle out of the top flag leaf taken as the flowering date and the height at flowering were noted separately for each plant, and the mean data are given in Table 1.

Table 1. EFFECT OF SOWING TIME IN *Sorghum Roxburghii* var. *hians*

Date of sowing	Mean height in cm. at flowering stage	Mean date of flowering	Mean flowering time in days after sowing
Feb. 15, 1949	527·0	25.10.49	253
March 15, 1949	504·33	25.10.49	224
April 15 1949	377·40	25.10.49	194
May 15, 1949	375·42	24.10.49	163
June 15, 1949	306·66	25.10.49	132
July 15, 1949	All plants died due to excessive rainfall		
Aug. 15, 1949	247·86	2.11.49	79
Sept. 15, 1949	182·85	26.11.49	72
Oct. 15, 1949	117·00	18.12.49	64
Nov. 15, 1949	Only a few seeds germinated but the plants died at young stage.		
Dec. 15, 1949	No germination		
Jan. 15, 1950	No germination		

The death of all the plants sown in July may be ascribed to practically incessant rainfall for fifteen days before and after the sowing, and want of growth or germination in the plants sown in November, December and January to comparatively lower temperature at the period; although when sown in pots in December there was germination and growth, but very much checked.

It will be seen that for widely different sowing times between February and June, the flowering takes place on October 24 or 25 when the daily light period becomes 11 hr. 28 min., and there is a gradual decrease in the flowering time and height at flowering with the lateness of sowing. The sowings of August, September and October flowered in November and December; but the flowering time and height are gradually shortened with the lateness of sowing.

Sown in earthenware pots 13 in. diameter and 13 in. height in March, the plants were exposed commencing at the age of nine days to 8 hr., 10 hr., 12 hr., 14 hr. and 16 hr. light periods, the shortening of the light period being done by transferring the pots to a ventilated dark room for the required period before sunset and bringing them out again after dusk;

and the lengthening of the light period was done by transferring the pots to a lighted room at sunset and exposing them to 200-c.p. electric light at a distance of 1–2 metres and bringing them outside after the completion of the required light period. The daily light period of the normal (control) gradually rose from 12 hr. to 13 hr. 30 min. and again fell gradually to 11 hr. 18 min. from the sowing to the flowering time. There were three pots per treatment each with four plants, that is, twelve plants per treatment. The mean flowering time and height at flowering are given in Table 2.

Table 2. EFFECT OF DIFFERENT PHOTOPERIODIC TREATMENTS. SOWN ON MARCH 15, PHOTOPERIODIC TREATMENTS COMMENCED ON MARCH 25

Treatment	Mean height in cm. at flowering	Mean flowering time in days after sowing	Remarks
8 hr.	139·1	67	The height of these plants sown in pots and the size of the panicles were much less than those grown in plots
10 hr.	144·4	67	
12 hr.	145·7	93	
14 hr.	206·7*		
16 hr.	198·4*		
Normal (control)	265·5	235	

* Last reading of height after the plants have ceased to grow and the leaves dried up, although there was no flowering in these plants.

It will be found that there is a remarkable earliness of 168 days in flowering in the short light periods of 8 hr. and 10 hr. from normal (control), in 12 hr. light period flowering takes place in 93 days and there is no flowering in the long light periods of 14 hr. and 16 hr. *Sorghum Roxburghii* var. *hians* (Jowar) is thus clearly a short-day plant.

The flowering of plants of widely different sowing times about the same time when the daily light period is 11 hr. 28 min. or less shows that, in its flowering behaviour, this plant is influenced by the daily light period more than any other factor.

Detailed results will be published elsewhere.

Our thanks are due to Prof. R. C. Lacy, Science College, Patna, for the supply of seeds, and to Sri P. Krishna Rao, millet specialist, Coimbatore, for identification of the variety.

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Gamete Behaviour in *Chlamydomonas*

Chlamydomonas Moewusii is a heterothallic species showing a difference in behaviour between the gametes of the two mating-types, of a kind not previously recorded.

When suspensions of 'plus' and 'minus' gametes are mixed in light, clumps are formed, and, after some minutes, pairs separate, which swim freely for 4–8 hr. During this period of motility there is no nuclear or cytoplasmic fusion, the cells remaining coaxially attached at their anterior ends by a short protoplasmic bridge and progressing regularly in one direction. Although both gametes retain their flagella, only one is active in propulsion. This can be observed under favourable conditions of illumination: the flagella of one cell beat actively, while those of the other trail behind with only occasional twitching.

In order to determine which is the active partner, both physiological and genetic methods of 'labelling' have been used.

(*a*) When cells are kept in darkness for 4–5 days, the protoplasts shrink away from the posterior walls. Such starved cells are readily distinguishable from those in the normal turgid condition. Starved 'plus' cultures may be mated with turgid 'minus', or starved 'minus' with turgid 'plus': in either case, the flagella of the 'plus' partner are those which remain active after pairing.

(*b*) Cells bearing a genetic marker have highly refractive metachromatic globules in the cytoplasm. Gametes of either mating-type may be labelled in this way, and observations of matings again show that the propulsion is effected by the 'plus' partner of a pair.

(*c*) Several 'paralysed' stocks of the 'plus' mating-type have been obtained by ultra-violet irradiation: the cells possess flagella but do not swim. When such cultures are mated with normal 'minus' cells, non-swimming gamete pairs result, a further confirmation that the 'minus' gamete ceases to play a part in swimming after pairing.

An investigation of genetic and chemical factors affecting flagellar action in *Chlamydomonas* is under way.

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Pectic Enzymes of the Fungus *Byssochlamys fulva*

Beavan and Brown[1] investigated the pectic enzymes of the fungus *Byssochlamys fulva* and were unable to detect pectin-esterase or polygalacturonase, although protopectinase was shown to be present by its disintegrating action on disks of potato tuber. They concluded that *B. fulva* elaborated a disaggregating enzyme which reduced the molecular size of pectin, without the production of galacturonic acid, on the lines suggested by Kertesz[2].

The examination of two cultures of *B. fulva* in this Department showed that both produced exocellular pectic enzymes, one culture being very active. By growth on suitable solid media, extraction with water, dialysis and solvent fractionation, concentrated preparations could be obtained, which reduced the viscosity of 1 per cent pectin solutions in a matter of minutes, whereas a preparation cited by Beavan and Brown[1] needed approximately ten hours. Purified preparations acting on sodium pectate freed from araban and galactan rapidly degraded the substrate. The amounts of pectin as measured by the calcium pectate method rapidly decreased, and reducing material was formed equivalent in one case to a 63 per cent hydrolysis of the original pectic acid. The reaction mixtures yielded considerable amounts of D-galacturonic acid, which could be estimated semi-quantitatively on the paper chromatogram[3,4,5].

Dialysed preparations acting on pectin at *p*H 6·0 rapidly produced acid, and the pectin-esterase activity could be determined by continuously titrating the acid formed[3] or by estimation of the methyl alcohol liberated.

Byssochlamys fulva therefore elaborates both pectin-esterase and polygalacturonase, and the results of Beavan and Brown are presumably due to the low activity of their preparation, and the well-known phenomenon that a profound decrease in viscosity of pectin can be accompanied by only a slight liberation of free reducing groups[2,6,7]. One preparation from *B. fulva*, for example, produced a 50 per cent drop in viscosity for a 0·5 per cent hydrolysis of the pectic acid.

The possibility, however, remains that a disaggregating enzyme in addition to pectin-esterase and polygalacturonase may be necessary for the degradation of pectin. It is interesting to speculate whether this hypothetical disaggregating enzyme is related to protopectinase, an enzyme the separate identity of which has never been clearly demonstrated.

Unpublished work on the relationship between the ratio of the reduction in viscosity to the logarithm of the amount of enzyme for pectic enzyme preparations acting on sodium pectate shows that the reaction occurs in two steps, and recalculation of some of the data of Matus[7] demonstrates a similar effect, which may indicate the successive action of two separate enzymes.

Whether enzymatic disaggregation of pectin can be produced without scission of a small number of glycosidic bonds is under investigation, and will be reported in detail elsewhere as part of a general study of the pectic enzymes of microfungi.

Acknowledgments are made to Miss M. Olliver and Mr. L. D. Galloway for cultures of *Byssochlamys fulva*, to Mr. G. L. Solomons for assistance with some of the experimental work, and to the Directors of H. W. Carter and Co., Ltd., for permission to publish this communication.

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Two Phases of the Water Metabolism in Newly Born Rats

The water metabolism of newly born mammals differs from that of adult animals. This difference is due to the fact that the former cannot increase their tubular re-absorption of water under conditions of dehydration to the same extent as adult animals[1]. The reason for this difference lies in the neurohypophysis of newly born mammals, which is morphologically and functionally immature[2]. I have tried to ascertain whether the water metabolism of newly born rats develops continuously, or whether there is a jump in its development. I have investigated whether there is a correlation between the functional development of the organ of sight and the quality of the water metabolism.

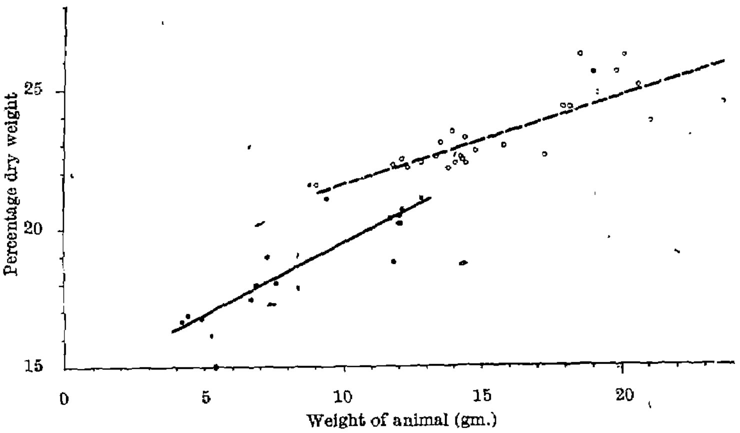

Fig. 1. Percentage dry weight in newly born rats : ●–●–, animals killed before their eyes opened ; o—o—, after their eyes opened

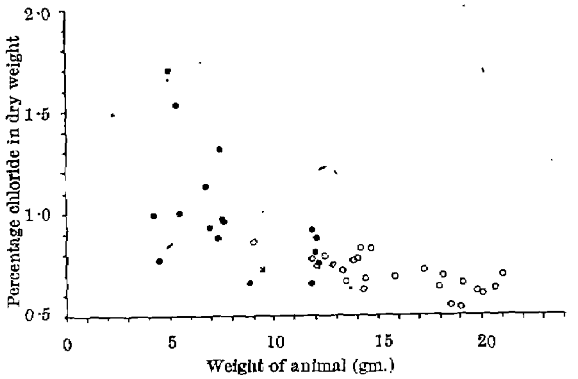

Fig. 2. Chlorides as percentage of dry weight in newly born rats : ●–●–, animals killed before their eyes opened ; o—o—, after their eyes opened

Forty-seven newly born white rats from eight litters (our own breed) were killed at various ages and the percentage dry weight and the chlorides as a percentage of dry weight were determined. The results are shown in Figs. 1 and 2. It was observed that at the time when the animals' eyes open (that is, when their weight is approximately 12 gm.) the percentage of dry weight increases suddenly by 10 per cent. Regression lines for the increase in dry weight are also shown in Fig. 1. It can be seen that the slope of the line showing increase in dry weight decreases at the time the eyes open from 27° 30′ to 17° 40′. Statistically, p for the difference of these two angles is approximately 0·05. Fig. 2 shows the percentage of chlorides in the dry weight for the same animals. It can be seen that the level of chlorides falls steadily ; at the time the eyes open, however, their variability decreases.

These experiments demonstrate the existence of correlation between the functional development of the organ of sight and the quality of the water metabolism in newly born rats.

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Nature of the Vitamin B_1-sparing Action of Fat

From a large number of investigations it is known that the appearance of the symptoms of polyneuritis in animals fed on an aneurin-deficient diet is accelerated by increasing the amounts of carbohydrate fed and delayed by replacing carbohydrate by fat[1]. This has led to the formulation of the so-called 'sparing action of fat on vitamin B_1' [2].

The verb 'to spare' can have a double meaning here, namely, 'to dispense with' or 'to use less of'[3]. The effects mentioned could be, and have indeed been, interpreted in both ways. According to the first meaning, an increased carbohydrate ingestion would provoke symptoms of aneurin deficiency at a level of this vitamin in the tissues at which these symptoms would not yet appear with lessened carbohydrate intake. According to the second meaning, the increased consumption would entail a bigger loss of aneurin from the tissues. Former investigations carried out in order to decide between these two possibilities gave contradictory results and did not allow of a definite conclusion because of the inaccuracy and elaborateness inherent in the rat-growth test used for the estimation of vitamin B_1 [4,5,6].

The following experiment was therefore carried out. Three groups of ten male pigeons weighing 400–500 gm. were placed on the following diets which were administered directly into the stomach by forced feeding. The foods were practically free of aneurin, but contained all other vitamins in adequate amounts.

Table 1. Food Intake (in gm.) per Pigeon per Day

	Group *A*	Group *B*	Group *C*
Casein	2	2	2
Sucrose	18	6	—
Peanut oil	—	—	8
Salt mixture	0·3	0·3	0·3
Mixture of other vitamins and essential fatty acids	0·09	0·09	0·09

After 13 days, the animals were sacrificed and the aneurin pyrophosphate content—as this is the form in which the vitamin is present and active in animal tissues—of several tissues was determined by the manometric method[7]. Samples were always taken of the thoroughly minced whole organ. The results are given in Table 2.

Table 2. Aneurin Pyrophosphate Content in μgm. per gm. of Fresh Tissue (all values are means of 10 determinations)

	Group *A*	Group *B*	Group *C*	*P*-value of differences according to Fisher[8] *B*—*A*	*C*—*B*	*C*—*A*
Liver	0·69±0·10*	1·87±0·24	3·33±0·26	<0·001	<0·001	<0·001
Heart	1·45±0·16	2·02±0·21	2·53±0·05	<0·05	<0·05	<0·001
Cerebrum	1·57±0·08	2·16±0·11	2·83±0·13	<0·001	<0·01	<0·001

* Standard deviation of the mean.

The results clearly demonstrate that a larger consumption of carbohydrate causes a quicker depletion of the tissue; 'to spare' thus means 'to use less' in this case. Nitrogen determinations showed that the differences are not due to a different protein content of the tissues. Determinations of free aneurin in the excreta practically ruled out any significant contribution by the intestinal flora to the observed phenomena.

Therefore, the conclusion must be drawn that the increased metabolism of carbohydrate caused by the increased carbohydrate intake leads to a quicker disappearance of aneurin pyrophosphate—a co-enzyme in carbohydrate catabolism—from the tissues. The loss of the vitamin is highest in the liver, the central organ of carbohydrate metabolism. Further experiments suggest that the depletion of the liver is indeed directly related to the increased carbohydrate uptake and not due to a displacement of stored vitamin to other tissues.

This work forms part of investigations on the metabolism and physiological function of aneurin carried out by Prof. H. G. K. Westenbrink and collaborators. Full details and discussions will be published elsewhere.

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Vitamin B_{12} as an Anti-Anaphylactic

Following the pure hypothesis that macrocytic anæmias could be due to an anaphylactic blockage of the bone marrow, especially as regards erythropoiesis, it was supposed that folic acid, the action of which in these anæmias has been of some help, might have an anti-anaphylactic action. Experiments were therefore performed which showed folic acid to possess a protective action on the anaphylaxis of the guinea pigs[1]. I thought it would be interesting to see whether such an anti-anaphylactic action might be shown also by vitamin B_{12}, which has turned out to be very effective, even in a very small dosage, in the treatment of pernicious and some other macrocytic anæmias[2–4].

As a source of vitamin B_{12}, 'Rubramin' (Squibb and Son) has been used. The 'Rubramin' has been tested as in the case of folic acid on anaphylactic shock of the guinea pig.

Twenty-two guinea pigs (medium weight, 450 gm.) were each sensitized with ½ c.c. of normal horse serum by intraperitoneal injection. After fifteen days, five of them, used as controls, were given intracardiacally the shocking injection of 1 c.c. of serum. Of the five, four died immediately after the injection, and one survived, but showed all the signs of severe shock.

Five other guinea pigs were given 30 μgm. of 'Rubramin' intraperitoneally and the same shocking injection of 1 c.c. of serum fifteen minutes later. All survived, although signs of shock were present. Finally, the twelve remaining guinea pigs were given 45 μgm. of 'Rubramin' intraperitoneally and the same shocking treatment fifteen minutes later. In this case ten of them survived, with signs of shock present to a much lesser extent, and two of them died.

These experiments indicate that vitamin B_{12} has a protective action on the anaphylactic shock of the guinea pigs. This action reveals itself using doses as low as 60–90 μgm. per kgm. body-weight. It is worth while to mention also that in patients allergic to liver extracts, no allergic reactions to vitamin B_{12} were noticed[5].

Without discussing whether the mechanism of action of vitamin B_{12} or folic acid in the macrocytic anæmias could be the result of their anti-anaphylactic action, it should be pointed out that the liver interfering with their metabolism might exert an anti-allergic action in the organism. Thus it is well known that a disturbed liver function plays an important part in some cases of human allergy.

Another important conclusion is that no other substance is able to protect the guinea pig from anaphylactic shock when used in such small quantities as vitamin B_{12}. For example, if we take the common anti-histaminic drugs ('Benadryl', 'Pyribenzamine', 'Dimetina') their protective dose is 3–10 mgm. per kgm. body-weight[6-9], which is thirty to fifty times greater than the dose required in the case of vitamin B_{12}.

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Effect of Rain in Calming the Sea

IN view of the difference between the results obtained by E. W. S. Ashton and J. K. O'Sullivan[1] and those of C. F. Barnaby[2] for the number of vortex rings formed when drops of water fall into a container of water, we have repeated the experiment.

The apparatus was set up as described by Ashton and O'Sullivan. As a preliminary investigation the experiment was performed using different dyes. It was found that fluorescein gave the clearest results, especially during the first few drops before the top layers of the water became coloured. As a comparison with the dyes used by the above-mentioned workers, we tested the effect of cresyl blue and aniline orange, and in both cases we recorded lower results than with fluorescein, due, we believe, to initial rings being missed. The following results were obtained using fluorescein. At each height, drops of mean weight 0·036, 0·057 and 0·098 gm. were used. Table 1 gives detailed results. The secondary drops mentioned by Barnaby were noticed, and although some produced vortices these only travelled a short distance and hence would have little effect under Reynolds's theory[3].

Table 1

Dropping height (in.)	% No. of drops which formed vortex rings Weight of drop (gm.) 0·036	0·057	0·098
6	80	76	80
65	50	26	54
97	39	17	19
170	5	1	0

We have extended the experiments to investigate the effect of wind on the rain drop and the action of neighbouring splashes on the number of vortices. An 8-in.-diameter fan was used to produce an air current; but unfortunately it was only strong enough to have an effect on the drops from 6 in. There was a significant decrease in the number of vortices, as shown in Table 2.

Table 2

Angle of strike (degrees)	% No. of vortex rings formed Weight of drop (gm.) 0·036	0·098
0	80	80
15	38	42
30	4	6

The action of neighbouring drops was investigated by arranging four similar dropping tubes containing pure water at the corners of a square with the funnel containing coloured water at the intersection of the diagonals. As is seen from the results in Table 3, a decrease in the number of vortices compared with the single-drop experiment was found. Only the largest drop (0·098 gm.) was used.

Table 3

Dropping height (in.)	% No. of vortex rings formed Length of diagonal 8 in.	10 in.
6	16	40
170	0	0

From our results, we suggest that rain does not calm the sea by producing vortex rings as suggested by Osborne Reynolds. We have been unable to find any reference to the calming of ocean waves by rain drops in the works of authors on ocean waves[4]. We therefore suggest that the observed calming of the sea by sailors as reported by Reynolds is due to the rainstorm being accompanied by a fall in wind velocity and consequently a decrease in the amplitude of the waves.

We should like to acknowledge the kindness of the headmaster of the Andover Grammar School, Mr. C. L. Denyer, for permission to use the Physics Laboratory at the School for the above experiments.

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[3] Reynolds, O., "Papers on Mechanical and Physical Subjects", 86 (Camb. Univ. Press).
[4] Cornish, V., "Ocean Waves" (Camb. Univ. Press).

FORTHCOMING EVENTS

Monday, July 10—Friday, July 14

Society of Chemical Industry (at Newcastle-upon-Tyne).—Annual General Meeting.

Tuesday, July 11

British Standards Institution (at 24 Victoria Street, London, S.W.1), at 3 p.m.—Annual General Meeting.

Tuesday, July 11—Saturday, July 15

Fourth World Power Conference (in London).—Technical Sessions at 10 a.m. and 2.30 p.m. each day at the Institution of Civil Engineers (Great George Street, S.W.1), the Institution of Mechanical Engineers (Storey's Gate, St. James's Park, S.W.1), and the Institution of Electrical Engineers (Savoy Place, Victoria Embankment, W.C.2).

Wednesday, July 12

Institute of Welding (at 2 Buckingham Palace Gardens, London, S.W.1), at 2.30 p.m.—Twenty-seventh Annual General Meeting.

Royal Meteorological Society (at the Central Forecast Office, Meteorological Office, Dunstable).—Summer Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Advisory Botanist (with a degree in agriculture or pure science, with honours in botany)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (July 15).

Demonstrator in the Department of Physics—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (July 15).

Harry Ferguson Scholarships in Agricultural Engineering, Ford Motor Company Scholarships in Agricultural Engineering, and a David Brown Scholarship in Agricultural Engineering—The Registrar, King's College, Newcastle-upon-Tyne (July 15).

Lecturer in Bacteriology—The Secretary, The University, Birmingham 3 (July 15).

Lecturer in the Electrical Engineering Department—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 15).

Lecturer in Psychology—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5 (July 15).

Mechanical and Aeronautical Engineers (Experimental Officer grade, unestablished) at the Royal Aircraft Establishment (Aerodynamics Dept.), Farnborough, Hants, for work in flight research, supersonic and subsonic wind tunnels, and in the seaplane tank—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.301/50A (July 15).

Responsible Lecturer in Biology at the Luton and South Bedfordshire College of Further Education—The Borough Education Officer, Education Office, Town Hall, Luton, Beds (July 15).

Scientific Technologists (with a good general training in chemistry, preferably up to Degree standard) in the Board's Coal Survey Laboratories at Nottingham, Birmingham and Leeds—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/225 (July 15).

Lecturer in Bacteriology in the Department of Clinical Pathology—The Secretary, Charing Cross Hospital Medical School, 62–65 Chandos Place, London, W.C.2 (July 17).

Lecturer (Grade I) in Microbiology in the Department of Industrial Fermentation—The Secretary, The University, Birmingham 3 (July 20).

Principal Scientific Officer (with a first- or second-class honours degree in engineering or an equivalent qualification, and must be an Electrical Design Engineer with an intimate knowledge of production methods and the characteristics and design of radio components) in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3143 (July 20).

Mathematicians (Experimental Officer grade) for (*a*) research in subsonic tunnels and seaplane tank, (*b*) aeroplane project work involving performance calculations and analysis, and Physicists (Experimental Officer grade) for experimental work on analysis and research in subsonic tunnels and seaplane tank, in the Aerodynamics Division of the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.175/50A (July 22).

Physicists and Electrical Engineers at a Ministry of Supply Research and Development Establishment in the South Midlands: Principal Scientific Officers (A.170/50A) to (*a*) lead a team in electronics research with special reference to micro-wave techniques, and (*b*) lead a team engaged on development of fire control radar equipment; Scientific Officers (A.171/50A) for research and development work on Army radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 24).

Lecturer in Physics, and Lecturers or Assistant Lecturers (2) in Economics, at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 29).

Research Officer (Biologist), in the Division of Fisheries, Cronulla, N.S.W.—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 quoting No. 2907 (July 29).

Lecturer or Assistant Lecturer in Parasitology, an Assistant Lecturer in Bacteriology, and a Lecturer in Pathology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (July 31).

Principal Scientific Officer (unestablished) in the London headquarters of the Ministry of Supply, for the supervision of all aspects of research and development in helicopters from project stage to completion of tests on experimental types—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.290/50A (July 31).

Senior Lecturer in Chemical Engineering at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (July 31).

Warden of Flatford Mill Field Centre, East Bergholt, Colchester, and an Assistant Warden for duty (in the first instance) at Dale Fort Field Centre, Haverfordwest—The Director, Council for the Promotion of Field Studies, 10 Exhibition Road, London, S.W.7 (July 31).

Lecturer in Physics, and a Senior Lecturer in Physical Chemistry, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 1).

Lecturer in Geology (Mineralogy and Petrology), and a Lecturer in Economics, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Senior Lecturer or a Lecturer in Geology at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Assistant Experimental Officers (posts are in various Government Departments and cover a wide variety of scientific, including engineering, qualifications)—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068.

Assistant Soil Conservation Engineer (with degree in civil engineering and experience in land drainage work) in the Department of Agriculture, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27329/13.

Engineering Graduate in the Research Laboratory at Derby—The Scientific Research Manager, Railway Executive, L.M. Region, Euston Station, London, N.W.1.

Inspectors of Agriculture (with a sound training in practical agriculture and holding a University degree or College diploma in agriculture or equivalent academic qualifications) in the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Agriculture (A.R.)'.

Lecturer in Dairying—The Bursar, Seale-Hayne College, Newton Abbot, Devon.

Lecturers (2) in Technical Chemistry with industrial and/or teaching experience, (*a*) to specialize in Fuel Chemistry and Technology, and (*b*) to specialize in High Polymer Chemistry and Technology—The Secretary, Royal Technical College, Glasgow.

Senior Scientific Officers and Scientific Officers in various Government Departments, for posts covering a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2887.

Water Engineer in the Public Works Department, St. Kitts-Nevis, Leeward Islands—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27329/37/50.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bulletins of the Theory of Differential Periodicity. No. 1, March. Pp. 18. (Avoca, Co. Wicklow: G. F. Sleggs, Templelusk, 1950.) 7*s*. for about 100 pages. [95

Library Science Abstracts. Edited by Dr. C. B. Muriel Lock and Reginald Northwood Lock. (Quarterly.) Vol. 1, No. 1, January–March. Pp. 36. (London: Library Association, 1950.) Annual subscription, 15*s*. [95

Medical Research Council. Special Report Series, No. 271: Epidemics in Schools; an Analysis of the Data collected during the Years 1935 to 1939. By Dr. E. A. Cheeseman. Pp. vii+96. (London: H.M. Stationery Office, 1950.) 3*s*. net. [95

Other Countries

Government of India: Central Waterpower Irrigation and Navigation Research Station, Poona. Research Publication No. 13: The Behaviour and Control of Rivers and Canals (with the aid of Models). By Sir Claude Cavendish Inglis. Part 1. Pp. iii+280+19. Part 2. Pp. 281–487+19. (Poona: Central Waterpower Irrigation and Navigation Research Station, 1949.) 16.8 rupees; 25*s*. 6*d*. [35

Canada: Department of Agriculture. Report of the Science Service for the Year ended March 31, 1949. Pp. 104. (Ottawa: King's Printer, 1949.) [35

United States Department of Agriculture. Leaflet No. 265: Control of White Pine Blister Rust, a Co-operative Effort to Prevent Damage to the White-Pine Resources of the United States. Prepared by the Division of Plant Disease Control. Pp. 8. (Washington, D.C.: Government Printing Office, 1950.) [95

Beach Erosion Board: Corps of Engineers. Technical Memorandum No. 13: Longshore Current Observations in Southern California. By Dr. Francis P. Shepard. Pp. v+54. (Washington, D.C.: Government Printing Office, 1950.) [95

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THE UNIVERSITY IN THE MODERN WORLD

THE full report of the proceedings of the 1949 Conference of the Universities of Great Britain and Northern Ireland (*Nature*, 165, 104; 1950) has just been published. At that Conference, Sir Walter Moberly's book "The Crisis in the University" was discussed, and it is interesting to find from a recent book by Dr. R. S. K. Seeley* that Sir Walter Moberly's views are reflected to a considerable extent in Canada. There is, further, a remarkable similarity of thought between these Hazen Lectures and the general trend that found expression in a series of talks on "The Idea of a University" broadcast by the B.B.C. in the Third Programme during March and April. The article on "Research, Reality and Religion" contributed by the Very Rev. H. A. Jones, Provost of Leicester, to the *Universities Quarterly* for May should help further to remove misunderstandings as to the meaning of Sir Walter's remarks about religion and the universities apparent in the rambling discussion at the Home Universities Conference, which led Sir Walter to protest rather feelingly.

Mr. Jones gives it as his opinion that while the investigation of the physical universe with no consideration of metaphysical or theological questions, on the assumption that ultimate reality is unknowable, has liberated enormously the energies of scientific men, the effects on the work of the universities as a whole are sufficiently dangerous to warrant the warnings in Sir Walter Moberly's book. In the first place, the growth of technological studies has tended to produce an attitude of mind which is the exact opposite to the attitude of the man of science as described by Thomas Huxley in his famous letter to Charles Kingsley. While the scientific man engaged in research is already in the psychological and spiritual attitude which makes worship possible, the technician (as such) must undergo a psychological revolution before worship is other than somewhat unreal. Linked with this greater tendency to treat spiritual reality as unknowable or non-existent, there is the conception of education as primarily a process of acquiring knowledge; and with the increasing demands on the teaching side of the universities in comparison with research, it is little to be wondered at that most students have little opportunity to acquire the truly scientific attitude of mind.

Even in science, Mr. Jones believes we can no longer escape from metaphysics. If the knowledge and insights derived from modern science are to be truly integrated with those derived from other aspects of human experience, we must overthrow or modify the metaphysics of Hume—or at least of Hume as mediated to us through Huxley. Knowledge of the deepest kind, knowledge which demands most of men and women, is not knowledge of things or of logical propositions, but knowledge of persons; and Mr. Jones believes we shall not escape from our difficulties in education until we return to this. More than courses in the history and philosophy of science will be needed, and he lays his chief stress on the need for a renewed sense of the common fellowship of all those who are engaged in the tasks of teaching, research and scholarship. He believes it would be comparatively easy, even in a large university, to create a conviction that the many and various subjects of study and research are different aspects and expressions of one deep underlying spiritual reality. If scientific men can be included in the society which the collegiate system makes possible in the older universities, and which—as Michael Oakeshott stressed in the first of the talks on "The Idea of a University"—makes a university a place where the student has the opportunity of education in conversation with his teachers, his fellows and himself, religion and theology would take their rightful place in the life of the universities and make their contribution to the common fundamental attitude of mind which such a society tends to produce. Mr. Jones remarks that it is in reality itself and not in any one aspect of the human approach to it, or even in the sum of such human approaches, that the integration of human life can be found.

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* The Functions of the University. By the Rev. R. S. K. Seeley. Pp. ix+79. (London, New York and Toronto: Oxford University Press, 1948.) 6s. net.

Mr. Oakeshott's view that the pursuit of learning in a university is essentially a conversation, depending on the stimulating contact of minds at all stages of development, particularly the contact of minds trained in different disciplines, found general support in the subsequent talks in the series, though other speakers, like Lord Lindsay of Birker, quickly pointed out that the university could not be so detached from the world or the preparation of men and women for the professions as Mr. Oakeshott suggested. A university has always had, as Sir Walter Moberly said, some sort of social purpose, both changing society and being changed by society. The real danger is that to which Mr. C. R. Morris, Prof. R. Pascal and Sir Walter all directed attention—that under the pressure of present conditions there will be no common body of knowledge, and the conversation postulated by Mr. Oakeshott will not take place.

None of the talks provided much guidance, however, as to how this is to be achieved. Prof. P. M. S. Blackett did not discuss this issue at all; indeed, his address illustrated Mr. Jones's contention that we commonly fail to distinguish between the scientific and the technician's frame of mind. In the concluding talk Sir Walter urged convincingly that the universities would fail to make their proper contribution to the modern world if they did not contribute to the solution of the problem of values as well as of technical problems. Much in the modern scientific temper is admirable and must be incorporated in the new tradition and framework. But, as Sir Walter put it, if the Christian scheme of things is true at all, it is relevant to university studies, and to recognize this is to give effect to Prof. Pascal's principle that the university should study man in the totality of his activity and his relations. To ignore this is to produce a distorted picture and to adopt a partisan attitude, not one of neutrality as between a secularist or a religious outlook.

It is here that Sir Walter is more convincing than his opponents. He does not believe in concealing unreality or glossing over differences or doubts, but has faith in the competence of the universities to train leaders for a changing society. He would have students helped to disentangle and examine critically their assumptions and emotional attitudes—the assumptions underlying the particular studies they pursue, the profession for which they are preparing, the judgments they are accustomed to make and the political or religious convictions they are accustomed to hold. He would also explore the basic values of the university so as to reach a greater clarity and agreement; and he sees clearly that there are some issues so fundamental that neutrality is impossible, and reiterates that we cannot without absurdity have an open mind about the value of having an open mind.

In this address, as in his reply to the discussion at the Home Universities' Conference, Sir Walter seemed to remove some of the misinterpretations of his book. A university cannot do its work without unfettered freedom of thought and utterance, relentless pertinacity in following the argument wherever it leads, punctilious accuracy in noting and recording evidence, a judicial temper in approaching controversial questions, a respect for opponents and a sustained effort to understand them. Beyond this, however, Sir Walter urges that the university may properly share in a few other assumptions basic in the community to which a university belongs, such as, in our Western world, an impregnable respect for the individual human person. Such assumptions affect educational policy and, in general, as he says rightly, we need a more penetrating analysis of such values and a greater measure of agreement than exists at present.

Such a re-examination and re-assessment of tradition cannot be made either without the universities contributing or without a re-examination of the Christian element in that tradition. The universities, as Sir Walter reminds us, are among the most obvious organs of the community for the discussion and sifting of ideas, and they cannot fully serve the community even in that way if they ignore or exclude the religious issue and take up an attitude which, as Sir Walter has done well to reiterate, is not one of neutrality but of opposition. It would be instructive to learn whether the discussion groups used in the Department of Electrical Engineering at the University of Birmingham, as recently described by Prof. A. Tustin, as well as Prof. L. J. Russell at the Home Universities' Conference, to stimulate the personal development of students and to broaden their interests, have confirmed the soundness of Sir Walter's judgment here.

That experiment of the last three years is, moreover, particularly interesting in view of the main points made by Dr. Seeley, whose Hazen Lectures, referred to earlier, were concerned especially with the student element in the university community and the place of religious values. It was also urged in a recent series of articles on scientific education in the *Times Educational Supplement* that a really well-thought-out course of doctrinal religion is an essential part of the training of a scientific worker. What he wants to know and what he is entitled to know is what theories about the relations between men and men, the relation between man and the universe and the relation between man and God the Christian Church actually puts forward, and on what facts of experience these theories are based. It is of the greatest importance that he should see that there are real problems to be solved in this as well as in the material sphere, and that great thinkers are, and have been, active here as well as in science.

This is really part of the general informative course designed to give the academic man of science an overall view of the scientific picture of the universe and man. It is the complement of the specialist part of the education of the scientific worker in the academic field, which must endeavour principally to furnish him with an adequate weapon for further investigation, whether this takes the form of research or of general inquiries into daily problems. Methods and techniques are as important as acquiring a mass of information. When we consider that this should include teaching the man of science how to frame an experiment, carry it out accurately and assess and evaluate the information thus obtained, as well as to judge the degree of reliability of his results and where and how to find the material for checking his work by the work of others, it should be apparent that this part of the scientific side of his training is linked with exactly the type of discussion of assumptions and values which Sir Walter Moberly and Dr. Seeley are concerned to promote.

The value of an approach of this type is particularly apparent where there is a tendency, as Dr. Seeley suggests there is in Canada, for the general public to think of a university as a place of teaching rather than of learning, and to forget that the university is a community of men and women engaged in the common task of the pursuit of knowledge. That pursuit, as Dr. Seeley admits, must be selective; but it is not haphazard, and it is a profoundly spiritual one. A university does not discharge its responsibility to itself if it does not accept responsibility for guiding and directing its students as well as for teaching and research. One danger to-day is that university expansion has hindered the satisfactory discharge of the first of these tasks because the student body has grown and the teaching staff become too small. A second danger is the absence of clear thinking about the nature of the freedom to which the university student is entitled. There are limits to such individual freedom wherever a common end is sought, and Dr. Seeley regards it as one of the great weaknesses of the Canadian universities that students are rarely made aware of the nature of the community which they enter. At some point the student must be made aware of the discipline involved in an inquiry after truth, and in words that remind us of Sir Walter's book, Dr. Seeley remarks that it has yet to be established whether there is a place in our civilization for a university which is nothing more than a collection of free individuals with no common ground and has therefore no contribution to make to society at large.

Dr. Seeley reiterates this point after quoting Milton's definition of a complete and generous education—"that which fits a man to perform justly, skilfully and magnanimously all the offices both private and public of peace and war". The bearing of this on a university education lies in the adverbs which Milton uses, and the difficulty of attaining the ideals of a university with a minimum of staff is accentuated if the number of students is restricted now that students are increasingly entering the university from homes where books are a rarity and conversation seldom reaches an abstract level. That in itself encourages the tendency to think that the universities must turn out the finished product rather than men and women who are prepared for any occupation but fitted for no particular one.

Against this Dr. Seeley gives clear warning, and he firmly holds that a university should be jealous of its standards and produce graduates of only the highest excellence, as well as guarding against the temptation to multiply courses in order to satisfy outside interests. He believes that a university must be ready to abandon courses if they are no longer valuable or if better ones are devised. The main interest of his book, however, lies in what he says, after stressing the imperativeness of maintaining standards, about stimulating creative activity and about the universities recognizing their cultural responsibilities. If university students go out without an appreciation of cultural pursuits, without a knowledge of how to use leisure graciously and creatively, civilization will be poor indeed.

Here Dr. Seeley would go further than the experiment being tried at Birmingham, for while recognizing the value of group discussion, he urges that more discussion is also needed between teachers and students on the subject-matter of courses. Further, with Sir Walter and Prof. Russell, he recognizes that students should be given some indication of the principles upon which moral behaviour is to be founded, and that in practice we cannot be completely impartial. Obligation is laid upon those who believe in a moral purpose to teach as if they believe in it and to let the students know that there are those who believe in it. Neutrality here means the denial of moral purpose, and denying to students the knowledge that the existence of moral purpose is a live issue and that there are those who cannot find a meaning to life on any other terms. If our burning passion for truth is based upon a living belief in a moral purpose for society, we cannot communicate the passion without communicating with it the source from which it comes.

The whole spirit of inquiry is fundamental to university life, and for that reason Dr. Seeley believes that the university should offer a wide field for experiment in Christian thinking and living. He appears to be thinking in terms of Sir Walter Moberly's creative minority with a unique opportunity of demonstrating the Christian life and ethic unimpaired by denominational partialities. Like Sir Walter, he regards the university as responsible for seeing that the nature of a well-rounded life is made clear, and like him he recognizes that a university cannot permit within its society elements which are self-destructive, which indulge in intellectual dishonesty or are subversive of everything for which universities stand. Freedom in the pursuit of truth is essential in a community of scholars; but it must be conditioned by the rights and purposes of the community as well as of the individual: if the two ever clash, those of the community must come first.

It is within those limits that Dr. Seeley claims that the protagonists of both the secularist and the religious point of view must be free to examine critically and explain their own assumptions and values, and to demonstrate their contribution to living a full life. That was Sir Walter's fundamental claim in "The Crisis of the University"; and unless it is admitted, the universities will be unable to exert their full influence against the pressure groups the existence of which in society is, in Dr. Seeley's view, one of the greatest threats to the freedom of the universities as well as to the values in national life, such as impartiality, integrity, moral courage and a sense of perspective. The plea is not for propaganda but for living—the provision of an antidote for fear, the confidence in which the passionate search for truth is conducted and the kindling of a spirit of adventurous life. The discharge of that function of a university safeguards a community of scholars from disintegrating into departmentalism, and inspires its members with both a concern for, and an understanding of, the values on which society depends.

A striking feature of all these discussions on the functions and the purpose of a university is the parallel they present with discussions on the preservation of political and industrial democracy. Here once again the solution of our problem lies largely in the creation of small groups in which the individual can find a real sense of partnership, and to which he or she can feel able to make some effective contribution. The universities have to establish such groups in which effective contact is possible between the junior and the senior members of the university community, and in which the discipline and tradition of a university are understood and freely accepted. In such groups and communities the critical re-examination of assumptions and values in which interpretation and fresh synthesis are possible can proceed; they can gain an appreciation of the best elements that make up the university or the Western tradition, whether drawn from the scientific or the ethical side, and even the junior members would be able to form their own judgment and make their decisions with an open mind and with the fearless and obstinate integrity which is a safeguard against the racketeer in whatever guise he appears. In such an atmosphere, not only would any attempt at propaganda be instantly detected and corrected, but also there should be no danger, such as that of which Prof. Pascal spoke, of professional ethics and loyalty building walls around itself and proving a rival to a wider social consciousness and ethics, because we have here a principle in harmony with the essence of scientific study.

CONSERVATION OF THE RESOURCES OF THE AMERICAS

Proceedings of the Inter-American Conference on Conservation of Renewable Natural Resources, Denver, Colorado, September 7–20, 1948

(Department of State, Publication 3382, International Organization and Conference Series 2, American Republics 4.) Pp. xi+782. (Washington, D.C.: Government Printing Office, 1949.) n.p.

THE United Nations Conference on the Conservation of Natural Resources, which met at Lake Success during August–September 1949, was preceded by an inter-American conference which covered approximately the same field, but excluding minerals. All the countries of the New World were represented, and the delegates and observers met at Denver, Colorado, during September 7–20, 1948, under the presidency of Charles F. Brannan (United States Secretary of Agriculture), with William Vogt as secretary-general. The programme included exhibitions and field trips, and Mr. Harry S. Truman was personally introduced at the closing plenary session.

The greater part of the day-to-day work was carried out in six parallel sections: 1, human populations and productive capacity of the land; 2, renewable resources and international relations; 3, land use and the social sciences; 4, dynamics of renewable resources; 5, education in conservation dynamics; and 6, making conservation effective. Altogether, some 111 papers were presented. A number of resolutions were passed urging the Pan-American Union, working in close relationship with the Food and Agriculture Organisation and with other agencies of the United Nations, United Nations Educational, Scientific and Cultural Organisation and other bodies, to take appropriate steps in the development and conservation of natural resources and especially in Nature protection and wild-life conservation.

On one day, September 18, the delegates were taken to an 850-acre western ranch four miles south-east of Denver, which was chosen as typical of 200 million acres of farm and ranch land, and there, before their eyes, it was remodelled by more than a hundred modern farm machines in a single day. Special attention was paid to soil erosion control in this area of 14 inches of annual rainfall. It is to be hoped that a report may be available later as to the progress of this farm.

Again and again in the discussions, emphasis was placed on the present lack of knowledge and the need for research; on the present rapid increase in populations; and the fact that "no population can long outrun its resources". It is perhaps surprising to find Kingsley Davis, director of the Division of Population, Columbia University, dogmatically asserting that "obviously both the United States and Canada are reaching the end of their period of rapid population growth . . . in the 1990–2000 decade, there will be no growth at all but a loss in population". On the other hand, Dudley Kirk, of the United States Department of State, says that "the United States and Canada will have to make way for an increase of 25 to 30 million more people by 1975". Many of the papers are valuable because they give brief summaries of the conditions in the countries concerned—such as Uruguay, Mexico, El Salvador and Colombia—and throughout the conference the emphasis is on soil erosion, "undoubtedly encountered everywhere" in the Latin American countries, according to Manuel Elgueta, of Costa Rica, who urges that the "development of agriculture is bound to create more serious destruction of the land capital unless immediate study of land-use is carried out".

In view of the world-wide interest in under-developed areas and the implications of Mr. Truman's Fourth Point, this warning is salutary and timely—there is great danger that modern machines designed for mid-latitudes may cause untold harm in the little-understood tropics.

L. Dudley Stamp

ON EXORCISING GHOSTS FROM MACHINES

The Concept of Mind

By Prof. Gilbert Ryle. Pp. 334. (London : Hutchinson's University Library, 1949.) 12*s*. 6*d*. net.

FOR thirty years the Logical Positivists have been rolling up their sleeves, spitting on their hands and boasting about the hard work they are just about to do with their marvellous new tool 'semantics'. A feature of the new tool is supposed to be a sort of super-language to correct the defects of ordinary language. Prof. Gilbert Ryle, in the meantime, has done some genuine work in correcting the defects of language, with no fuss, no jargon, no meta-languages : just plain English and common sense. He has also produced a very readable book, although it is rather too long and repetitive.

He takes up a traditional philosophical problem, the relation of mind and body, in order to show that a dualistic theory of the Cartesian type, the "myth of the ghost in the machine" as he puts it, leads to verbal confusions. Common speech and common sense in most cases avoid these confusions successfully, recognizing the distinction between persons and things, but treating persons in a unitary way—not splitting them up into a ghostly half and a mechanical half. Prof. Ryle's method may be described as empirical study at second-hand. Through the medium of ordinary linguistic usage which has survived the test of time, he appeals to common experience which each of us can confirm for himself by reflexion. This is the useful and legitimate kind of linguistic analysis and criticism; but it is at least as old as Socrates.

Prof. Ryle shows successfully that in use the theory of the ghost in the machine tends to turn into that of a little machine inside the big one, or a little man inside the big man, carrying out hidden operations inside a private theatre or peep-show. The thing becomes a tangle of false analogies and mixed metaphors. Prof. Ryle calls false analogies and mixed metaphors by the portentous title of "category mistakes", and incidentally falls into one himself in illustrating his use of the term (p. 16). He appears to assume that we can always use direct speech with literal meaning and always avoid metaphors and analogies. Yet his own language is often just as metaphorical and analogical as the language he condemns, though the metaphors and analogies are different. In trying to exorcise the ghost from the machine, he is in danger of emptying out the baby along with the bath water.

These dangers are clearly seen in the chapters on sensation and imagination. For example, he dismisses "images" in a very ingenious but high-handed way. When a person goes through the motions of looking or pretends to see, when there is nothing real to look at or to see, then, he says, the gap is the supposed "image". This conclusion (or prejudice) is that of one with very little mental imagery of his own who ignores all the evidence of special investigations of the past hundred years. What about the child with eidetic imagery who, when asked to draw an elephant, projects an image on the paper and runs his pencil round the outline ? What about the person with a photographic memory who, when asked to quote something, can see the printed page and read off the required words ?

Prof. Ryle deals in an equally high-handed fashion with the 'sense-datum' theory of perception, but never explains what he proposes to put in its place. Here, however, he is on stronger ground and his arguments deserve consideration. Yet here also he has no right to ignore all special studies of the subject, even in the sacred name of common sense. It is not far short of two centuries since Thomas Reid published his "Inquiry into the Human Mind", also an attempt to exorcise ghosts from machines and also in the name of common sense. Either ghosts are very stubborn or common sense is very feeble.

A. D. Ritchie

INTRODUCTION TO THE SCIENCE OF VISION

Vision and the Eye

By Dr. M. H. Pirenne. (Frontiers of Science Series.) Pp. xx+187. (London: Chapman and Hall, Ltd., 1948.) 12*s*. 6*d*. net.

THE study of vision has now become so extensive and the literature on it so specialized that the student approaching the subject is often bewildered. Moreover, physicists, physiologists, psychologists and artists have all contributed to the welter of information. As a result, objective physical data on the properties of light, observations made during physiological experiments on animals and man, introspective analysis of subjective sensations and even practical observations on the mixing of pigments and on the effects of their juxtaposition may often be found inextricably entangled in many of the existing volumes of vision.

The author of this book is therefore to be congratulated on his objective and limited approach. He has wisely selected certain basic facts, which do not by any means cover the whole field ; and he is mainly concerned with attempting a synthesis of how patterns of electromagnetic radiations, called light, falling on the eye are translated by the eye into such selective excitation of nerve fibres in the optic nerve as can eventually give rise to the perception of form, colour, distance and the like. The author is not concerned with the subjective aspects of vision, and, by eliminating these, he immediately clears the field of many of its more difficult entanglements and thus provides the student with a clear and logical approach to the subject.

While, however, the general approach is objective and logical, it is also somewhat conservative. There is also, perhaps, some lack of sympathy with the more biological aspects of vision, as, for example, in the discussion on the parts played by rods and cones and in the evolutionary aspects of the visual mechanism. Occasionally, also, the reader may feel that the author is not entirely devoid of bias in the interpretation of observational results. For example, in Fig. 75 a single curve could be drawn through all the points with apparently as much accuracy as the two curves suggested on theoretical grounds. Again, on p. 156 it is stated that "there does not seem to be any evidence that entirely rod-free fields have different colour vision" from those containing rods, although previously, on p. 141, one finds that, when a field subtending 20′ in diameter falls on the middle of the fovea (which, on p. 27, is stated to be rod-free), then "the characteristics of colour vision correspond to a dichromatic system. All lights of the spectrum can be matched by suitable mixtures of blue light and red light." This apparent inconsistency is not, in fact, as glaring as it may seem at first sight, since there are other possible causes for the dichromacy of the foveal centre besides the absence of rods; but perhaps the point could, with advantage, have been made more explicit.

In spite of this, however, the book is well considered and clearly written, and forms an excellent introduction to the complex study of vision. The analysis of the minimum requirements of energy for the perception of light and of pattern, which incorporates much of the author's own investigation, is of particular interest. E. N. WILLMER

ENGLISH FARMING BOOKS IN THE EIGHTEENTH CENTURY

More Old English Farming Books

From Tull to the Board of Agriculture, 1731 to 1793. By G. E. Fussell. Pp. ix+186+8 plates. (London: Crosby Lockwood and Son, Ltd., 1950.) 15*s.* net.

SOME time ago Mr. G. E. Fussell published a volume on Old English farming books covering the period 1523–1730; he has now followed this up with a companion volume dealing with the period 1730–93. The dates can be fully justified: 1731 was the year in which Jethro Tull published his famous "New Horse Houghing Husbandry" which made the successful cultivation of turnips possible and so opened the way to the Norfolk rotation, the final break with the ancient three-field system. 1793 was the year of foundation of the first Board of Agriculture, which did so much towards the development of the craftsmanship that later raised English agriculture to the highest level in Europe.

The general reader would have been helped if Mr. Fussell had begun with an outline of the agricultural history of the period in relation to what had gone before and what came after; the author preferred, however, to start right away with an account of Jethro Tull and William Ellis. Of the two, Tull was by far the more interesting personality. An Oxford student who had to abandon his studies and political ambitions for health reasons, he had taken to farming but gave up for a time to travel in the south of France and in Italy, where he saw with admiration the methods of cultivating the vineyards; on his return he set out to adopt similar methods on his farm. His efforts are described in his book; the first edition is very rare, but William Cobbett's edition of 1829 is not difficult to find, and it is made more entertaining by Cobbett's own very racy comments. Tull has always aroused interest and admiration among agriculturists for his gallant struggle against adversity, due partly to a spendthrift son, and against sickness, working as he says "in pains of the stone and other diseases as incurable and almost as cruel".

Mr. Fussell's survey ends with Arthur Young, most famous of agricultural writers—"that wise and honest traveller" as John Morley called him—whose later years were terribly saddened by the death of his favourite daughter and by blindness.

In between Tull and Young came a crowd of much smaller people whom Mr. Fussell aptly calls the minor prophets, but who necessarily take up a considerable part of the book.

The period was agriculturally far more important for its practical achievements than for its writings. Bakewell, Townshend and Coke of Norfolk were all bringing about revolutionary changes in farming practice, but none of them wrote anything; indeed, it has been part of the irony of agricultural history that some of the best agricultural writers—Tusser, Young and others—have been very indifferent practitioners, whereas some of the best practical farmers have felt no urge to write. Some of the volumes had intriguing titles—"The Way to be Rich and Respectable", "Strictures on Agriculture", "Modern Eden; or the Gardener's Universal Guide"—but they lack the picturesqueness of some of the sixteenth- or seventeenth-century books and particularly the sonorousness of the Elizabethans, for none of the eighteenth-century publishers could approach the colophon of the 1578 Heresbach, "Imprinted at London for John Wight, dwelling in Paules Church-yarde, at the great North doore of Paules"; however, there is contained in some of them a good deal of shrewd common sense and information about agricultural practices which cannot easily be found elsewhere.

A few points might receive attention if another edition is called for. Tull's idea of tillage as a substitute for manure was developed by the Rev. S. Smith, of Lois Weedon, in the late 1840's and published by him in his pamphlets "A Word in Season" in 1849 and "Lois Weedon Husbandry" in 1856, and by 1858 the former had reached its sixteenth edition; copies of both pamphlets are in the Rothamsted Experimental Station along with other agricultural treasures. The method excited a good deal of attention, as labour was cheap and manure dear. It was tested at Rothamsted on Hoosfield during 1851–54 but found to be ineffective; the results were published in the *Journal of the Royal Agricultural Society* for 1856. Burnett's pamphlet, the only one mentioned by Mr. Fussell, was not published until 1859. The author gives the date of the first edition of William Ellis's "Modern Husbandman" as 1743; the Rothamsted copy is dated 1742, and includes only the months May–October. The Dublin edition of 1743 includes the whole year. The Rothamsted copy of the Dublin edition of Hales's "Compleat Body of Husbandry" (1757) is in four volumes, not two; the London edition of 1758–59 is also in four volumes. The London and Dublin editions differ in content and especially in arrangement. Mr. Fussell does not mention the "Continuation . . ." (1759), of which Rothamsted has a quarto edition. The second edition of Tull's "Horse Hoing Husbandry" is dated 1743, not 1740. It was the "Supplement to the Essay . . ." that reached a second edition in 1740; Rothamsted has no copy of the first, even if there ever was one.

The student of this period of agricultural history will find the volume useful; no other book deals with the subject so fully. E. JOHN RUSSELL

TOBACCO MOSAIC VIRUS CRYSTALS AND THREE-DIMENSIONAL MICROSCOPIC VISION

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A. R. STOKES and W. E. SEEDS
Wheatstone Laboratory, King's College, London ;

AND

G. OSTER
Royal Institution, London

CRYSTALLINE inclusion bodies in tobacco plants infected by tobacco mosaic virus have been known since 1903[1], and circumstantial evidence has made it appear likely that these crystals are composed largely of the virus protein[2,3]. The present work makes it appear even more likely than before that the crystals are pure virus protein, and shows the crystals to be of considerable interest from several quite different but related points of view. On account of the exceptionally large dimension of the protein particle, it has been possible for the first time to make, in part at least, a structure analysis of the crystal using visible light in a manner analogous to that of X-ray diffraction. As a result, it has been possible to settle the controversial question[3] of the length of the rod-shaped virus particle in the living plant. Also, the interpretation of the appearance of the crystals, as seen with the microscope, leads to a theory of the formation of images of three-dimensional objects[4]. We also wish to report some new observations on the optical properties of purified virus protein.

Previous observations on the optics and crystallography of what we shall assume to be tobacco mosaic virus crystals (though we must stress that it has not yet been proved that the crystals consist of virus protein alone) have been somewhat restricted[3], partly due to the difficulty of making suitable microscopic observations on bodies which cannot be removed from the plant. We have confirmed the fact that the crystals in leaf-hair cells show hexagonal prism and base faces only and are positively birefringent[3] ; and we have measured the birefringence, obtaining the thickness of the crystal by rolling over an isolated hair cell containing the crystal. The birefringence is 0·0046 and, if we assume the crystal to be composed of isotropic rod-shaped particles lying parallel to the hexagonal axis and use the birefringence value of wet virus gel, the water content of the crystal is one of two values, either about 30 or 60 per cent. We have made use of the Wiener formula of form birefringence[5], which is not accurate unless the water content approaches 100 per cent. An accurate theory of form birefringence for hexagonally packed rods is required and is being prepared[6]. The refractive index of the crystal relative to cytoplasm was measured directly by observing, with the Bertrand lens, the deviation of a pencil of light passing through two crystal faces inclined at 60°. The cytoplasm probably has a refractive index close to that of plant sap ($\sim 1{\cdot}344$) and this observation suggests a water content in the crystal of approximately 60 per cent. The interference figure in convergent light was observed after compensating the birefringence of the cell walls ; the crystals were uniaxial or, at least, if biaxial, β was less than 20°. The ultra-violet absorption spectrum (ordinary ray) of the crystal has been measured using a reflecting microscope. As expected, this spectrum agrees well with that obtained with pure oriented virus gel when the electric vector of the light is perpendicular to the rod-length of the virus particle.

The most interesting feature of the crystals was discovered, however, when the crystals were seen to be crossed by regularly spaced light and dark bands when viewed near extinction with crossed nicols and a bright light source (Fig. 1). This meant that the crystals did not have precisely straight extinction, but were composed of flat layers about 3000–6000 A. thick lying parallel to the basal face of the crystal, and that, from one layer to the next, the optic axis was inclined alternately a few degrees on one side and then the other with respect to the hexagonal axis ; in other words, the crystals were finely lamellar-twinned. Observation of bent crystals showed, as one would expect, that the light and dark bands interchanged as the crystal was turned through extinction. The bands had the same appearance when viewed in any direction normal to the hexagonal axis.

The width of each band was frequently about 3000 A. and never less, and it was very tempting to suggest that the ~ 2800 A. long virus protein rods observed in the electron microscope[7] compose the crystal, each layer in the crystal being built up of rods packed side by side and pointing in a direction slightly inclined to the normal to the plane of the layer ; in other words, the width of the bands observed was equal to the length of the virus particle. Various models of the crystal composed of helical and zig-zag arrangements of straight rods have been considered, but none has yet been found which accounts for all the properties of the image and of the diffraction spectra described below. One difficulty is that the structure is not constant, the thickness of the layers tending to increase, apparently continuously, as the crystals grow. In early stages of infection (about one week), the crystals are thin hexagonal plates composed of only a few layers

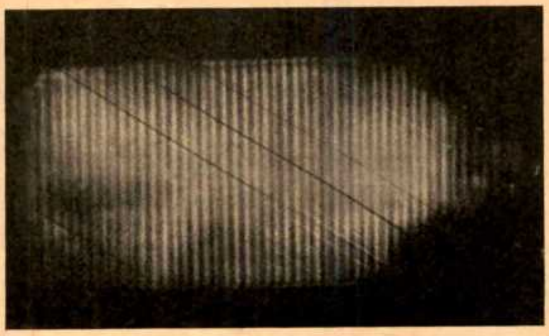

Fig. 1. Crystal of tobacco mosaic virus between crossed nicols. × 1,450

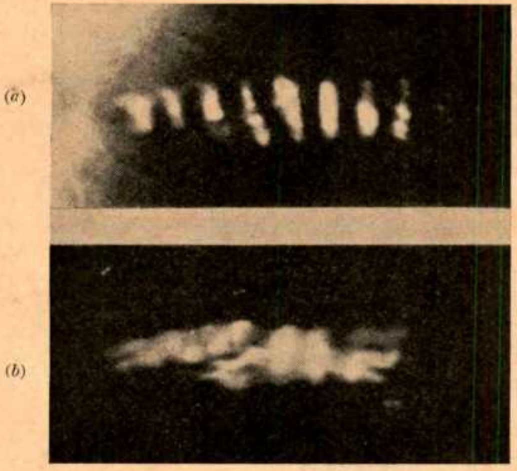

Fig. 2. Tobacco mosaic virus crystal showing helical edges, and bands between crossed nicols. × 2,650
(a) Near extinction position; (b) 45° from extinction position

(crystals of one or two layers only have been observed), and as the time of infection increases the crystals grow in the direction of the hexagonal axis, the number of layers increasing.

The presumably helical arrangement of the virus particles in the crystal causes the prism edges of the crystal to be themselves helical. In rare crystal fragments one sometimes finds that the pitch and angle of the helix have both become exceptionally large, and in these cases the helical contour of the crystal shows very clearly (Fig. 2). The bands which appear between crossed nicols show that the optic axis for any layer of the crystal is parallel to the edge of the crystal and to the length of the virus particle. In such a crystal the virus particles have probably aggregated end to end, and the pitch of the helix bears no special relation to the length of the unaggregated particle, 2800 A. Normally, however, it is clear that the particles are not aggregated, because the crystals show marked basal cleavage and the individual layers building up the crystal can sometimes be seen clearly in dissolving crystals jutting out sideways from the main body of the crystal (Fig. 3). On allowing a fragment of leaf to stand a few hours in distilled water, the crystals can be seen dissolving and reaggregating in a most entertaining fashion. We have seen (and photographed) paracrystalline needles similar to those observed by Beale[2], but crossed by bands; banded tactoids; crystals without external geometry but crossed by highly distorted bands; birefringent spherulites; banded laminæ; systems of small tactoids; and crystals containing spherical inclusions. It is clearly a characteristic of the virus to aggregate in a remarkably large number of ways.

The appearance of the bands in the normal crystals was surprising in one respect, that, although the crystal was often extended 10 or 20 μ in a direction normal to the plane on which the objective was focused, the contrast or 'visibility' of the bands was very high. Clearly those parts of the crystal out of focus were not contributing much out-of-focus light which would reduce the contrast of the image. The explanation of this phenomenon is surprisingly simple if one recognizes that any three-dimensional object in which there is a periodic variation, in one direction only, of any optical property such as scattering, absorption, birefringence or refractive index, will exhibit Bragg reflexion of light; and it is only as a result of the interference between the direct light beam and the Bragg reflected light that the periodic lamellar structure will be rendered visible. As the direct and reflected light waves may be considered as plane, the result of their interference is visible in the microscope as a system of equally spaced parallel dark and light bands. Bands of this type can also be seen in lamellar twinned crystals of potassium chlorate in which Bragg reflexion of visible light has previously been described[3].

Between crossed nicols the first- and second-order diffraction spectra from virus crystals can be observed using the Bertrand lens (Fig. 4), and the images showing the first and second harmonics of the band system may be observed if the crystal is illuminated at the required Bragg angle. The phenomena are identical with those for plane gratings as described by Abbe, except that diffraction is limited to angles of incidence corresponding to Bragg reflexion. Well-formed virus crystals used as crystal monochromators show separation of the 5460 and 5780 A. lines of the mercury spectrum.

It is interesting to note that if one has an object composed of equally spaced and roughly vertical laminæ alternately slightly stained and clear, the highest-contrast image is obtained not by passing light rays vertically through the whole depth of the laminæ, but by illuminating at the Bragg angles. An account of a theory of three-dimensional microscopic vision and resolving power will be given elsewhere[4], but one of the main conclusions is immediately apparent and may be stated as follows: the image of an object consisting of an extended periodic arrangement of vertical (or somewhat inclined) laminæ corresponds with a section of the object cut by the plane on which the microscope objective is focused, provided the numerical apertures of the objective and condenser are sufficient to pass light which will give the various orders of Bragg spectra corresponding to the Fourier components of the periodic arrangement. If the object is not periodic, and consists of one or two laminæ, the image again corresponds with that part of the object focused on. The out-of-focus portions of the object do not appear blurred but contribute to the image in focus; however, as the Bragg angles are no longer defined in a non-periodic object, it is not possible to illuminate at the Bragg angles only, and general illumination is superimposed on the image. This kind of approach enables one to interpret with certainty the appearance

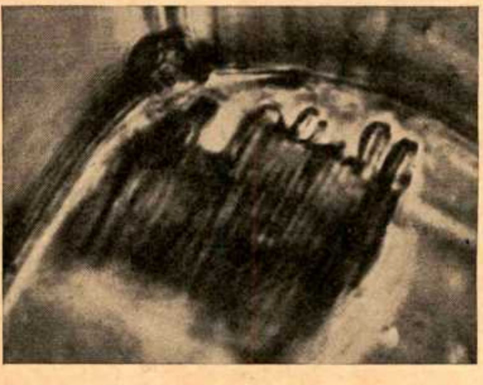

Fig. 3. Crystal of tobacco mosaic virus showing layer structure (crossed nicols with compensation). × 1,600

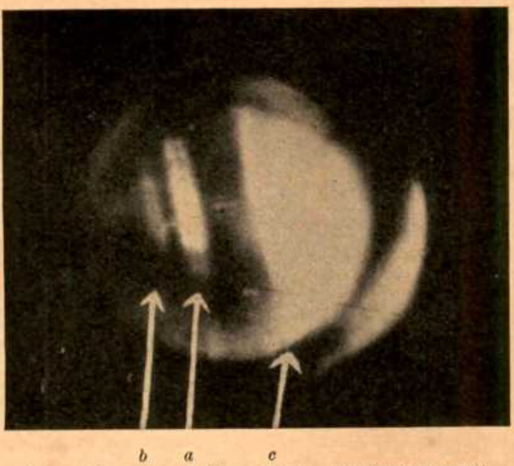

Fig. 4. Bragg spectra from tobacco mosaic virus crystal. (*a*) First order ; (*b*) second order ; (*c*) direct light

of many images in the microscope, such as those of edge-on views of birefringent sheets ; for example, some sperm heads, lamellar structures in chromosomes, lamellar twinned minerals, etc.

Oster[9] has found that, in freshly prepared virus gel in which the 2800-A. rods have not aggregated end to end, it is sometimes possible to observe iridescent domains which exhibit Bragg reflexion of visible light, indicating the presence of sets of planes of varying refractive index spaced approximately 3400 A. apart. He suggested that the virus particles 2800 A. long are arranged in sheets, the length of the particles being normal to the plane of the sheet, and with water separating the sheets. The band and Bragg phenomena in the virus crystals in the plant, however, only showed between crossed nicols, and the structure of the crystals was clearly different from that suggested by Oster.

One of the main objects of this investigation—to establish the length of the virus particle in the living plant—could not be achieved with certainty by a study of the crystals with helical structure. The discovery in the plant of a second and much rarer type of crystal with properties similar to those observed by Oster *in vitro* was therefore of great interest. These crystals showed bands when viewed with unpolarized light incident from one side at the Bragg angle. In this way a picture of the crystal in phase-contrast illumination[10] showing periodic variation in refractive index of the crystal was obtained. The crystals were positively birefringent (~ 0·005) with straight extinction, and showed bands between crossed nicols. The spacing varied from 4000 A. to 3200 A., and it was clear that the structure must be of the general form suggested by Oster, with layers of virus particles separated by water. As these crystals have the same properties as those observed in purified material composed of 2800-A. long particles, it is reasonable to suggest that they are crystals of pure virus, and we can almost say it is proved that these crystals in the plant are composed of the 2800-A. rod particles. The fact that these crystals, and the crystals with helical structure, are built up of layers of virus particles has been confirmed by Mr. H. L. Nixon[11], of Rothamsted Experimental Station, who has obtained electron microscope photographs of virus in dried plant sap showing aggregation of 2800-A. rods side by side and with their ends in a straight line at right angles to the length of the rod.

Finally, we wish to report that repetition of birefringence measurements on pure aggregated salt-free virus gel, approximately 100 per cent oriented, gave a maximum value of 0·0054 for wet gel and approximately 0·0007 for dried gel. Previous values[12] were 0·006 and 0·003 respectively. It would appear likely that the low value for dry gel is to be accounted for by the idea that the virus particles pack without interspace when dry, and that the birefringence of the virus is all form birefringence. Repetition of the experiments of Butenandt *et al.*[13] on the ultra-violet dichroism of oriented virus solution shows that their absorption curves are approximately correct, except that the curves for electric vector perpendicular and parallel to virus particle length should be interchanged. We feel that interpretation, as made by Butenandt *et al.*, of dichroism data of this kind is not justified and cannot tell us how the tryptophane and nucleic acid groups are arranged in the virus particle. The general difference between the heights of the two absorption curves for different directions of electric vector is likely to be due to form dichroism[14] resulting from the difference of refractive index of the virus particle and water. Also it is by no means certain, as has been suggested, that the tryptophane absorption peak at about 2900 A. occurs when the electric vector is parallel to the plane of the indole ring. Further study of this question is required.

We wish to acknowledge the very generous provision of plants and virus by Dr. R. Markham ; helpful suggestions from many workers in this field, in particular Prof. J. D. Bernal ; and the continual encouragement and advice of Prof. J. T. Randall. We are also very grateful to Dr. A. K. Wells, of the Geology Department, King's College, London, for the loan of the polarizing microscope used throughout this work.

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COLOUR SYSTEMS AND ATLASES

By C. L. BOLTZ
Colour Group of the Physical Society

THE word 'system' is in general use in our language ; so almost any paint-manufacturer's catalogue could be said to be related to a system. For the purpose of this article, however, it is used in a more restricted sense, and, in this restricted sense, a colour system is not necessarily associated with a collection of colour specimens—an atlas—although it often is. An atlas apparently unrelated to a system merits attention only when it is outstanding. For example, an atlas based on the mixture of colorants in stated proportions is, if comprehensive, useful to practitioners in applied colour. One of this sort containing 1,248 samples was produced by G. Plochere in California in 1948. An

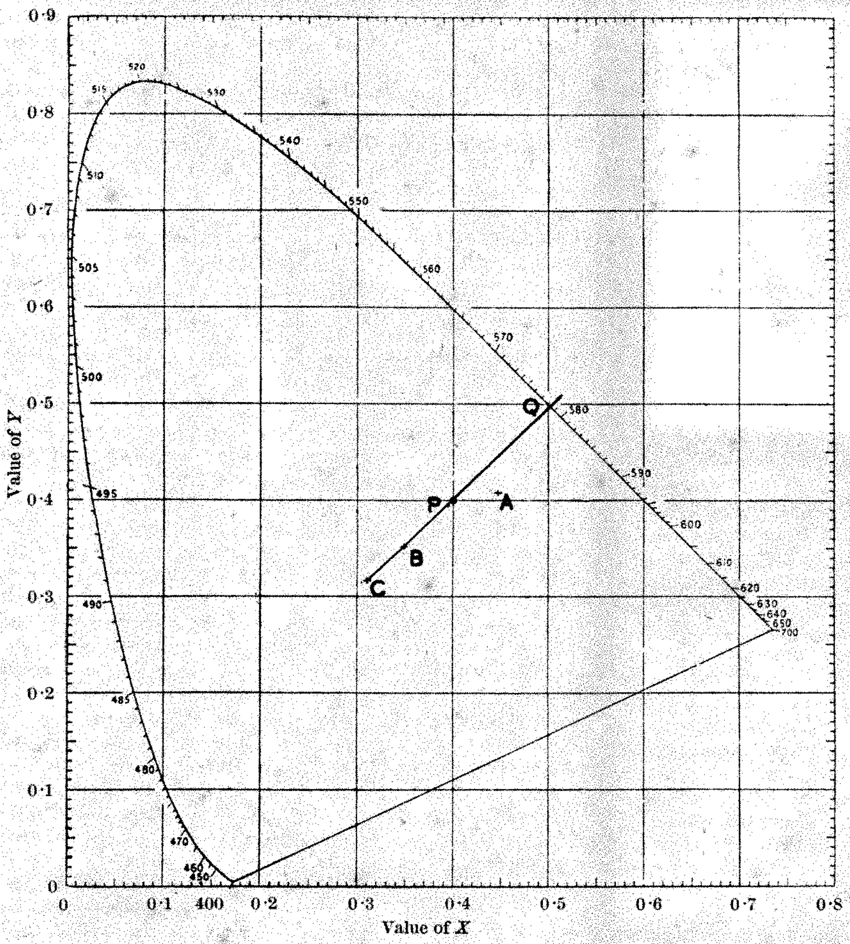

Fig. 1. C.I.E. chromaticity chart. P is the point representing colour specified by $x = 0{\cdot}40$, $y = 0{\cdot}40$. A, B, C are 'white' points corresponding to illuminants A, B, C. CP divided by CQ fixes the purity. The wave-length at Q fixes the dominant wave-length of colour P if illuminant C is used

atlas that takes into account the textures of surfaces is also outstanding; several have been produced by the British Colour Council, the newest scheme of which will eventually have a systematic numerical notation. Systematization of verbal descriptions to make a colour dictionary is another useful activity. Maerz and Paul produced their "Dictionary of Color" in New York in 1930, with 7,056 samples and a comprehensive comparative account of terms used in books and atlases. All these are useful; but, broadly speaking, an atlas unrelated to a system based on principles that can be discussed in visual terms is of restricted usefulness, and has no general significance for people interested in the science of colour.

It is in the devising of a system that the difficulties inherent in colour science appear. Any colour, whether from a primary or secondary source[1], is finally judged by a human observer. So, to the objective and subjective conditions that affect an observer, there must be added the subjective variables into which he can analyse his judgment of colour quality. These variables cannot be eliminated, but under controlled conditions they can be, so to speak, standardized, and then the most objective possible specification of colour quality can be made.

The C.I.E. system (I.C.I. in U.S.A.), agreed at meetings of the Commission Internationale de l'Éclairage from 1931 onwards[2], is an objective specification of colour matches. It is based on the matching of spectral colours by varying quantities of three monochromatic stimuli. Three hypothetical stimuli, not realizable in practice, can be calculated in such a way that a colour can be specified in terms of three tristimulus values, X, Y, Z, that express the ways in which radiant energy from an equal-energy source are distributed in contributing to the total colour stimulus received by a standard observer. Since any other colour is composed of a mixture of spectral colours, the integrated values of X, Y and Z specify the colour, provided the distribution of illuminant is also specified. The value of Y is arranged to give the luminance factor of the surface directly. The three chromaticity co-ordinates, x, y, z, are the ratios of X, Y, Z to their sum and therefore always add up to unity. Only two are therefore independent and they can be plotted on a two-dimensional diagram. When the axes of this diagram are arranged so that x is measured along the abscissæ and y along the ordinates, the result is the usual chromaticity chart (Fig. 1). Consequently the only variables needed are Y and two of x, y and z (usually x and y). These, with the stated illuminant, specify the colour. This specification is abstract and mathematical. It is accepted internationally and acts as a master reference-system. But it is without meaning for the inexperienced and can be used only by scientifically trained personnel. It gives little indication of the appearance of a colour. For example, it is not easy to see from the specification $x = 0{\cdot}40$, $y = 0{\cdot}40$, $Y = 0{\cdot}5$, illuminant C, that what is specified is a sort of pastel yellow when viewed in ordinary diffuse daylight.

A C.I.E. specification as ordinarily given bears no relation to subjective variables realized in the judgment of colour quality. The chromaticity chart, however, can be utilized to give a closer relationship to these variables. On the chart the spectrum locus is drawn (charts for regular use always have the spectrum locus shown and numbered), that is, a line joining points representing the chromaticity co-ordinates of all the spectral monochromatic radiations, the most saturated colours obtainable. If P is the point representing the colour specified above, a straight line drawn from the illuminant point C (that is, the 'white' point) to P, and continued, will cut the spectrum locus in a point Q. In this example the wave-length of Q is 5,784 angstrom units, and this is the *dominant wave-length* of the colour P. The proportion of CP to CQ specifies the *excitation purity* of the colour P, that is, a figure expressing where P stands between white light C and the saturated colour Q. So the derived specification of the colour is now in terms of dominant wave-length, purity and luminance factor. (These can also be derived directly from colorimetric matching by mixing white light with a monochromatic radiation.)

Anyone of normal colour vision, if confronted with a set of coloured patches, at once recognizes differences that he expresses as 'hue'—"*a* is red and *b* is blue". In addition, he can make a series consisting of patches of the same hue and changing only in *lightness*. Further, he can make another series of patches of the same hue and lightness but differing in a quality—"*a* is a greener green than *b*"—that is usually called *saturation*, an estimate of the proportion of colourfulness. However, it is not always precisely this quality that is estimated, but something else needing another name for an estimate of difference in degree of chromatic colour from achromatic colour (grey). If enough patches are available, he can make either of his series in steps of just noticeable difference. Even if enough patches are not available, he can still estimate equality of difference between successive steps. If he makes one series of a certain lightness and hue but differing in equal steps of colourfulness, and then tries to make another series of the same hue but much lower lightness and still differing in steps of colourfulness equal to the ones he made in the first series, he finds that the number of steps between achromatic colour and fully saturated colour is less; whereas if the estimates were in steps of saturation, a proportion, a greater number of steps should have been possible, because very saturated colours generally tend to be darker. This distinction between saturation and some other quality of colourfulness is a fine one and is unnecessary if comparisons are confined to series of the same lightness, when saturation and colourfulness are equivalent in subjective estimation.

The subjective variables hue, saturation and lightness correspond with the objective variables dominant wave-length, purity and luminance factor. But the correlation is not unity. For example, a series of constant dominant wave-length and luminance factor but differing purity is not necessarily interpreted as one of constant hue.

In the judgment of a surface colour, other subjective variables than the ones given above can be used. The Ostwald system employs four, consisting of hue, whiteness, blackness and colourfulness, and the paint-mixer uses variables related to these. The dyer has subjective estimates corresponding to the amount of dye that is needed and to whether the dye used is bright or dull. To some extent his variables can be correlated with those used by the paint-mixer, a subject discussed in the "Report on Colour Terminology" issued by the Physical Society.

The facts that correlation between subjective variables and C.I.E., or colorimetric, objective variables is not unity, that the plain C.I.E. specification is not immediately recognizable in terms of colour appearance, and that subjective variables vary among different users, make an atlas of specimens necessary for rapid and accurate work in all spheres where colour is used. Such an atlas should be stable and comprehensive, with a simple notation, related as nearly as possible to subjective variables, and related to a systematization. The notation used then gives a quasi-objective specification of a colour, a specification that is negotiable between users of the same system.

Two systems, and their atlases, have become widely known. One was devised by A. H. Munsell (1858–1918), a Boston (Mass.) art teacher, in 1905. The other was devised by the eminent German physical chemist F. W. Ostwald (1853–1932) in 1917. Their most recent atlases are the "Munsell Book of Color" and the "Color Harmony Manual" respectively, both produced in the United States in 1942. The former contains 960 specimens and the latter 943. C.I.E. analyses of the mat specimens of both atlases have been made by American physicists[3]. Recently (1947) Villalobos has produced his "Atlas de los Colores" in Argentina. It contains 7,279 specimens and is too recent for adequate appraisal here, though the great number of samples and their relation to a system based on three variables make it apparently worth serious consideration.

The Munsell system is a colour-appearance one. He systematized on the basis of three subjective variables, namely, hue, value, chroma. Value corresponds to lightness, chroma to the colourfulness mentioned above. Colour can never be specified with less than three variables, and so the custom has grown of referring to the spatial systematic arrangement of colours as a colour-solid. The Munsell solid is built from a central vertical trunk consisting of equal steps of achromatic colour from black at the bottom to white at the top. The subjectively equal steps of chroma go out horizontally like branches from the trunk. The different hues are distributed round the circumference of a circle in a horizontal plane. Thus a vertical mid-section consists of two parts, one on each side of the vertical axis. Each consists of a plane of constant hue but value increasing upwards and chroma increasing outwards to an irregular boundary depending on the value and

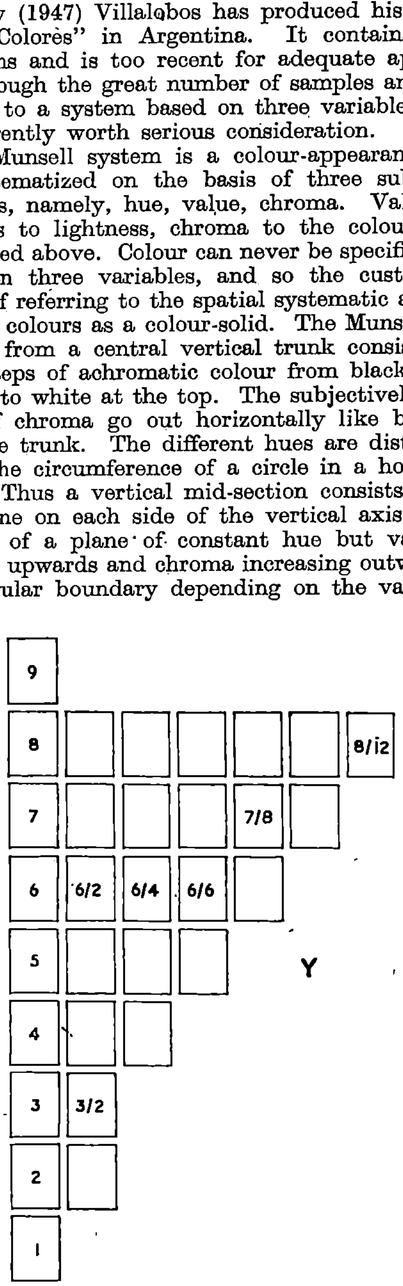

Fig. 2. Half a vertical mid-section through the Munsell colour solid. Figures up the left-hand represent values of achromatic series. Figures in other rectangles specify value and chroma. The hue is Y (yellow)

hue (Fig. 2). A horizontal section consists of colours of the same value varying outwards from the centre in chroma and around the centre in hue. His notation expresses hue, value, chroma, in that order. The stages of chroma can be extended as pigments of greater saturation become available.

The Ostwald system is often called a 'colour-mixture' one because the samples were originally determined by an objective mixture of colours. One variable is, of course, dominant wave-length, though Ostwald called it hue. The remaining colour quality is specified in terms of three variables corresponding to the objective variables of pure-colour content (that is, content of most saturated chromatic colour), black content and white content; for Ostwald, in revolt against the physicists' preoccupation with monochromatic spectral light, analysed surface colours, related to others as they usually are, into the four subjective variables of hue, pure-colour quality, blackness and whiteness. Mixing was done originally on a rotating disk, and if the black, white and pure-colour sectors are considered as fractions of the whole disk, then the total for any resulting colour must always be unity, giving an equation fundamental to the rationale of the Ostwald system : $w+b+c=1$. This has enabled Ostwald and his successors to utilize an equilateral triangle to display quantitatively the mixtures of w, b and c (dominant wave-length being constant for any one triangle), thus giving symmetry to the colour-solid. Ostwald then used the Fechner law connecting stimulus and sensation. He increased his objective mixture of colour sector of dominant wave-length with white (or black) by quantities the logarithms of which made equal increments. In this way, he argued, he bridged the objective–subjective gap according to scientific law. To make his colour-solid he arranged his pure colours (without black or white content) on the circumference of a circle in such a way that he could embrace the mystique of complementary hues being diametrically opposed. To every hue there belongs a vertical plane that is an equilateral triangle with an apex at the pure-colour part of the circumference and the black-to-white base vertically through the centre of the circle. Thus the whole solid becomes a symmetrical double cone. Ostwald numbered his hues and gave letters to the black and white properties. The notation then became a number followed by two letters (Fig. 3).

Neither the Munsell nor the Ostwald atlas is perfect, quite apart from whether the basic systematics is sound. Loci of Munsell constant-chroma specimens, for example, when drawn on a C.I.E. chromaticity chart, show sudden sharp irregularities. These are clearly errors, for whatever the shapes of loci might be, they ought to be smooth. Earlier Ostwald plottings showed even worse jumps. It is possible to estimate the correct mixtures for either system from smoothed curves. This has been done for Munsell colours[4], giving re-notations to be distinguished from the published book notations, and this offers the possibility of another atlas with more evenly graded steps. By postulating spectrophotometric curves of a certain type, physicists can state 'ideal' colours of maximum saturation and estimate the theoretical boundaries of sections of a colour solid. The Ostwald system has one outstanding defect, for the equation $w+b+c=1$ settles the pure colour as the existing pigment of greatest saturation; so as new pigments of greater saturation become available, the whole system, if it is to remain generally useful, has to be re-made to retain symmetry, equality of steps, and notation.

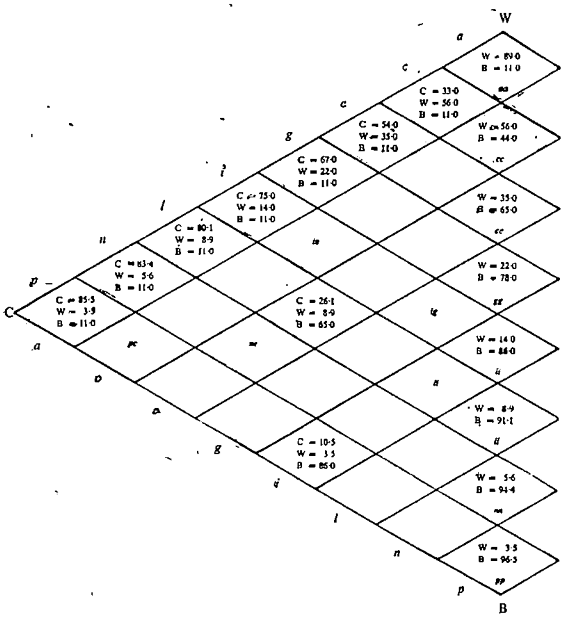

Fig. 3. Half a vertical mid-section through an Ostwald colour solid. It is an equilateral triangle. The proportions of white content, black content, pure-colour content for several positions are shown. The method of specifying the position in the triangle in the Ostwald notation is also shown in some positions. The vertical base on the right is the scale of achromatic colours increasing in lightness upwards

So much interest has been shown by professional men, industrialists and scientific men in this subject of colour systems and atlases, especially at a course on colour lighting organised at the Royal Institute of British Architects by the Council of Industrial Design and the British Colour Council, that the Colour Group of the Physical Society recently arranged a general discussion for its fiftieth meeting. The secretary, R. G. Horner, gave a general paper surveying the whole field, and much of the factual material of this article came from his paper. At the meeting, R. F. Wilson gave an account of his own atlases produced by the British Colour Council and already widely accepted in Great Britain, but it is not at all clear what the principles of his system are. It was notable that several non-academic speakers gave from personal experience their appreciation of the Munsell system, and appealed for the adoption of a standard system to eliminate the present confusion. Accordingly, the executive committee of the Colour Group of the Physical Society appointed on April 26 a sub-committee "to review the present situation regarding systems of colour description, to investigate the desirability of adopting a standard system, and to recommend any action that should be taken".

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[1] Terms used are defined in the Report on Colour Terminology (London: Physical Society, 1948).

[2] An account of the arguments leading to the C.I.E. system is given in Wright, W. D., "The Measurement of Colour" (Adam Hilger, Ltd., 1944).

[3] Kelly, K. L., Gibson, K. C., and Nickerson, D., "Tristimulus Specifications of the Munsell 'Book of Color' from Spectrophotometric Measurements", *J. Opt. Soc. Amer.*, **33**, 355; *Nat. Bur. Stand. J. Res.* (RP 1549), **31**, 55 (1943). Granville, W. C., Nickerson, D., and Foss, C. E., "Trichromatic Specifications for Intermediate and Special Colors of the Munsell System", *J. Opt. Soc. Amer.*, **33**, 376 (1943). Foss, C. E., Nickerson, D., and Granville, W. C., "Analysis of the Ostwald Color System", *J. Opt. Soc. Amer.*, **34**, 361 (1944).

[4] Newhall, S. M., Nickerson, D., and Judd, D. B., Final Report of the O.S.A. Subcommittee on the Spacing of the Munsell Colors, *J. Opt. Soc. Amer.*, **33**, 285 (1943).

THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON

FOR the fourth year in succession, the Chemical Research Laboratory of the Department of Scientific and Industrial Research held a series of 'open days' during June 27–30. The guests included staff from government departments, universities, industrial firms and the technical Press. In view of the large numbers attending in previous years an extra session was announced, and in this session places were reserved for industrial firms who had not previously received invitations. The response to this announcement indicated clearly that this opportunity to view the work in progress is welcomed by the scientific community.

The research staff of the Laboratory work within six main divisions, namely, the Corrosion of Metals Group, the Inorganic Chemistry Group, the Radiochemistry Group, the Organic Chemistry Group, the High Polymers and Plastics Section and the Microbiology Section. Formerly, microbiological investigations at the Laboratory were concentrated on the study of underground corrosion by the influence of sulphate-reducing bacteria; but, as will be shown later, the scope of the work has been considerably widened, and in January last an independent Microbiology Section was constituted. During the open days the work of these Groups and Sections was set out in great detail; but this note is confined to a brief statement of the nature of the work with special reference to the newer exhibits.

The Corrosion of Metals Group has a large programme concerning the corrosion of metals and its prevention in immersed and atmospheric conditions; in addition, investigations on soil corrosion continue in collaboration with the Microbiology Section. An electron diffraction apparatus has been installed and is being used for the examination of surface films stripped from metals by the iodine – methyl alcohol technique. Marked changes in the mechanism of film formation in the neighbourhood of 200° C. have been indicated in the course of a study of the oxide film on iron. Other films, such as those on nickel, aluminium and phosphated steel, have been removed and examined by the above technique.

Exhibits of special practical interest were those illustrating the use of sodium benzoate in conjunction with a smaller proportion of sodium nitrite as an inhibitor of corrosion, the use of which is particularly advantageous in that both cast iron and soldered surfaces are protected, a result that has hitherto been difficult to obtain when these metals have been present together in the same system. Glycol anti-freeze solutions, with and without the inhibiting chemicals, taken from new car radiators after running for some 2,500 miles were in striking contrast; the solution with the inhibitor was water-clear, whereas the other contained much suspended corrosion product. Work in collaboration with the British Rubber Producers' Research Association has revealed that the mixed inhibitor can be incorporated in rubber latex, and metal assemblies protected by rubber films with and without benzoate and nitrite showed clearly the benefit of the new inhibitor. A simplified atmospheric corrosion test has been devised with a view to its adoption by other laboratories; a prototype apparatus was seen in use.

In collaboration with the British Shipbuilding Research Association, a new research has been commenced on the corrosion of boiler tubes with particular reference to Scotch marine boilers; four experimental boilers have been installed.

In previous years the Inorganic Group has displayed specimens of gallium and germanium metals obtained from flue dust, and in view of the interest in these metals samples have been sent on loan to various laboratories for studies of their special properties. The physical properties of gallium are being investigated in collaboration with the National Physical Laboratory, and a newer exhibit showed the remarkable anisotropy of this metal in regard to electrical and thermal conductivity. A new investigation is the treatment of phosphate rock by methods to reduce the consumption of sulphuric acid. A non-hygroscopic product made by the action of a mixture of nitric and sulphuric acids was on view, together with examples of 'complete' fertilizers, that is, containing the three essential plant foods, phosphorus, nitrogen and potassium. Trials of these products as fertilizers are being undertaken, and other methods of converting rock phosphate are being studied. A grating spectrograph is now in operation to supplement the prism spectrographs for the analysis of metallic ores. A well-equipped microanalytical laboratory, which is part of this Group, now provides an analytical service for the Laboratory.

The greater part of the work of the Radiochemistry Group is carried out on behalf of the Division of Atomic Energy of the Ministry of Supply, and is concerned with the analysis and treatment of radioactive ores. Typical methods of treatment were exhibited, together with physical methods of analysis, including colorimetry, polarography and the measurement of fluorescence.

An exhibit of special interest was the further development in chromatographic methods for the separation and estimation of metals and acid radicals by the paper strip and cellulose column. During the year the separation of a number of groups of elements has been studied, including niobium and tantalum and the platinum metals and gold. A new automatic fraction collector has been designed and constructed in the Laboratory; this collects exact volumes of liquid independent of variations in flow-rate, drop-size or specific gravity of the liquid, and without contamination by traces from the preceding sample.

Methods for measurement of radioactivity include apparatus for active carbon (C^{14}), which is now used on a routine basis. The method depends on the counting of active carbon in carbon dioxide gas.

The Organic Group is concerned with the purification of organic compounds and the precise determination of their physical constants, the utilization of tar constituents and the preparation of organic intermediates containing labelled atoms (C^{13}). A precision freezing-point apparatus which has been developed at the Laboratory and uses a pulsating gas pressure to mix the liquid was exhibited.

A new exhibit was a low-temperature still for the preparation of pure hydrocarbons for use in the calibration of mass spectrometers; this was wholly constructed in the Laboratory and is fitted with automatic methods of control. Large-scale glass apparatus is being used on an increasing scale for unit operations, and examples were on view of a continuous solvent still, a reflux unit and a sulphonation apparatus.

An exhibit of considerable interest to organic chemists was a set of molecular models designed and constructed in the Laboratory. They approximate to the Stuart pattern and are machined from cast phenolic resin (see *Nature*, July 8, p. 59).

A newly erected spinning-band fractionating column is being used for the purification of fatty acids.

The main effort of the High Polymers and Plastics Section is being devoted to a study of the ion-exchange properties of high polymers, in particular the effect of polymer structure on ion-exchange equilibria and kinetics. An interesting exhibit was a 'mixed-bed' deionization column. This apparatus, which consists simply of a mixture of a strongly basic resin with a strongly acidic resin in a glass column, provides a very convenient method of preparing water of very low conductivity (specific conductivity $= 0 \cdot 1 \times 10^{-6}$ mhos).

The Microbiology Section exhibited work on the growth requirements of sulphate-reducing bacteria, showing the progressive increase of growth obtained in a series of media ranging from purely inorganic (autotrophic growth) to a very rich organic media. The importance of certain amino-acids for growth was illustrated. Other exhibits showed the quantitative reduction of sulphate to sulphide by these organisms and the competitive inhibition of the reduction by selenates. Work on the functions of sulphate reducers in the underground corrosion of metals was shown, with examples of corroded water and gas mains and suggested methods of prevention. Examples of the photosynthetic green and purple bacteria, which oxidize hydrogen sulphide to elementary sulphur, and of sulphur-oxidizing bacteria, were shown. Included in this Section is the newly formed National Collection of Industrial Bacteria, which maintains more than three hundred strains. Since January 1, 1950, the Collection has sent out some one hundred and fifty cultures in response to requests not only from research laboratories in Great Britain but also from Belgium, Ceylon, Czechoslovakia, Finland, France, Germany, Holland, India, Italy, Poland, Sweden and Trinidad. Methods of preservation, diagnostic tests and classification of bacteria were illustrated.

In addition to the research groups and sections, reference should also be made to the well-equipped workshops, where much of the special experimental plant is designed and constructed. An interesting exhibit on the machines were the jigs used in the preparation of the molecular models.

OBITUARIES

Dr. J. S. Gooden

John Stanley Gooden was born in Adelaide on April 11, 1920. His early education was at the Pultney Grammar School and later Saint Peter's College. He was at the University of Adelaide during 1938–41, where he concentrated on physics and mathematics, graduating in 1941 with first-class honours in physics. He was also proficient in sport, being a valued member of the lacrosse and cricket teams, and a good lightweight boxer.

Early in 1942 he joined the Australian military forces, working on radar problems. In that year he married Miss Claire Ward, daughter of the headmaster of Prince Alfred College, Adelaide. In 1943 he was invalided out of the army after applying for active service, and joined the Radio Physics Laboratories of the Australian Council for Scientific and Industrial Research in Sydney, where he became noted for exceptional experimental ability and his wide knowledge of physics. After the end of the War he worked on the production of one-million volt electrons from cavities excited by pulsed magnetrons, and was the first to attain success in this field.

In December 1945 Gooden arrived in England, and led the team under Prof. M. L. E. Oliphant in the construction of the 1,000 million-volt proton synchrotron in the Nuffield Laboratory at the University of Birmingham. He was responsible on this project for the major part of the general and detailed design and theoretical work, and his ability and energy were an inspiration to all members of the group. It is very sad that he has not lived to see the completion of this large and difficult project after putting into it more than four years of very hard work.

Dr. Gooden made considerable contributions to the theory of particle accelerators, in particular to that region where the motion cannot be regarded as either classical or extremely relativistic. For this work he was awarded the degree of Ph.D. of the University of Birmingham. He also developed the technique of paramagnetic nuclear resonance for the accurate measurement of rapidly rising magnetic fields, as in the proton synchrotron. This led him to investigate this effect under non-adiabatic conditions. During 1947 Dr. Gooden made an extensive tour of many physics laboratories in the United States of America.

Dr. Gooden was a member of the council of the Atomic Scientists' Association. His chief hobby was painting, and his outside interests included the history of art, music and social conditions. The friendship and hospitality of both him and his wife were highly valued by his colleagues.

In early May of this year, Dr. Gooden and his wife and young son flew back to Adelaide, where he fought hard to regain his health; but he died on June 9.

W. I. B. Smith

Dr. J. G. F. Druce

In the early hours of June 22, Gerald Druce died in a London hospital after six months of failing health and much pain. Born in 1894 at Leamington Spa, Druce was educated at Kendrick School and University College, Reading, and at University College, London, taking his M.Sc. in 1921. It was at University College that he first met Héyrovský, through whom he became interested in Czechoslovakia and its people. In 1920 he paid the first of more than thirty visits to that country, and in 1923 was awarded the degree of Doctoris Rerum Naturalium of the Charles University, Prague—a distinction shared by few Englishmen.

During most of his professional life, Druce was chemistry and botany master at Battersea Grammar School, and at the time of his death was head of the Chemistry Department. It was, in fact, in the temporary laboratory in the playground of the School at its original site on St. John's Hill, Clapham Junction, that Druce carried out his early work in search of the missing elements 43, 75 and 93, congeners of manganese, and in 1925 he published, with F. H. Loring, one of the three almost simultaneous papers announcing the discovery of 75 (rhenium). His pupils of those days will well remember the excitement of his isolation of a few colourless crystals of potassium perrhenate from pyrolusite. Yet Druce was an unassuming man; he knew his subject well and knew how to pass on his knowledge to others.

His practical classes were a model and his technique impeccable. The untidy laboratory and slapdash experimenting were anathema to him. Among his scientific writings were the monographs: "Brief Outline of the History of Science" (1925) and "Rhenium" (1948).

To mention his scientific work alone would be to tell only half the story, for Druce was a man of letters as well as a man of science, a scholar and a traveller. During the past thirty years he and his wife, and later their son, visited most of the countries of Europe, and he became fluent in many languages, including Czech and the Slavonic tongues. He once remarked that he learned his languages the 'easy' way, by living with the people. Yet, of the countries on the Continent, Czechoslovakia was his first love, and his writings on that country and its people revealed the depth of his understanding of their problems; in 1937 he was invested with the Order of the White Lion for his cultural and scientific work. He was also an honorary foreign member of the Masaryk Academy of Work and a corresponding member of the Royal Bohemian Scientific Society. In 1943 he was awarded the London M.A. degree for a thesis on "The Role of Men of Science in the Czech National Revival Movement".

His passing is mourned here and abroad, and those of us who received from him our first introduction to chemistry may indeed count ourselves fortunate.

KENNETH PANKHURST

Dr. H. Wambacher

ON April 25 Dr. H. Wambacher died in Vienna at the age of forty-eight after a long illness. Dr. Wambacher is mainly known for her work relating to scientific uses of photography, and especially for developing the method of detecting tracks in photographic emulsions of corpuscular rays due to atomic disintegrations and cosmic radiation. She worked at first together with Dr. M. Blau (now of New York). Her work is distinguished by the detection of the first multiple atomic disintegration ('star') in the emulsion of an Ilford plate, which was exposed for some months on the Hafelekar near Innsbruck (Tyrol). This discovery was followed by several publications concerning the occurrence of 'stars', their dependence on the number of tracks, the altitude, etc. The results of this work were not only of the greatest interest to scientific workers in this field, but also were of value to manufacturers producing special plates for nuclear research.

Dr. Wambacher's work was acknowledged by the award by the Vienna Academy of Sciences of the Jgnaz Lieben Prize for physics, 1938 (together with Dr. Blau).

G. ORTNER

NEWS and VIEWS

Prof. Egon Orowan, F.R.S.

THE Massachusetts Institute of Technology has recently announced that Dr. Egon Orowan has been appointed to a full professorship on the staff of its Mechanical Engineering Department. He will be taking up his new duties in October 1950. Dr. Orowan was born in Budapest in 1902, and studied at the Technical University of Berlin-Charlottenburg, where he continued for some years as a teacher and carried out research with Prof. Becker. On his return to Hungary he was for some time in charge of the krypton gas works of the United Incandescent Lamp and Electric Co. Eventually Dr. Orowan left Hungary, and in 1937 he resumed research on the mechanical properties of metals in the Physics Department of the University of Birmingham. In 1939 he went to the Cavendish Laboratory, where his researches were at first supported by the British Iron and Steel Federation and later by the Nuffield Foundation. He was given the title of reader by the University of Cambridge, and has had a group of about a dozen research students working under him for a number of years.

Dr. Orowan is well known in Great Britain for his work in metal physics. He combines an active and inquiring mind with an outstanding ability to design and construct ingenious apparatus. He has worked upon the deformation of single crystals, the theory of rolling, plasticity at high rates of deformation, the yield point of steel, and many other problems. He has been a member of many committees, and has taken part in numerous scientific gatherings, where his lively mind always stimulated the discussions. He has received a number of honours while in Great Britain, among them the Thomas Hawksley Gold Medal of the Institution of Mechanical Engineers in 1945 and the fellowship of the Royal Society in 1947.

Royal Naval Scientific Service: Mr. W. R. J. Cook

MR. W. R. J. COOK has been appointed chief of the Royal Naval Scientific Service in succession to Sir Frederick Brundrett, now deputy scientific adviser to the Ministry of Defence (see *Nature*, July 1, p. 17). Mr. Cook, who is forty-five years of age, was educated at Trowbridge High School and the University of Bristol, where he obtained the B.Sc. degree with first-class honours in applied mathematics in 1925. He followed this with two years fundamental research in theoretical physics at the same University, obtaining the M.Sc. degree in 1927 before taking up an appointment under the War Office in the Research Department at Woolwich. During 1927–35 he was engaged on research work in field of gunnery ballistics, the determination of shell velocities in flight and of pressures, temperatures and rates of heat transfer in guns. From 1935 he worked on gas dynamics and rocket development, and in 1939 was transferred to the Ministry of Supply Projectile Development Establishment. In 1940 he was appointed to the Ministry of Supply headquarters as an assistant director in the Directorate of Projectile Development, and was responsible for the assessment and planning of rocket requirements and research. In 1943 Mr. Cook returned to the Projectile Development Establishment as superintendent (R. and D.) in technical charge of all research and development; but in 1945 he was again recalled to the Ministry of Supply headquarters as deputy director of the Directorate of Guided Projectiles. He became chief superintendent of the G.P. Establishment at Westcott in 1946. In 1947 he transferred from the Ministry of Supply to Admiralty service as the director of physical research in the Royal Naval Scientific Service. In this post he has shown outstanding ability and great energy, gaining a very high reputation with both Naval and scientific staff in a comparatively short period.

Aeronautical Engineering at Southampton: Mr. E. J. Richards

The appointment of Mr. E. J. Richards to the newly established chair of aeronautical engineering in University College, Southampton, marks a development of unusual interest. He goes to a department which has already achieved good simple material equipment for teaching and investigation. It has been devised and made with the simplicity which is a necessary consequence of the small funds which have been available. An example of this development is the 6 in. × 2½ in. supersonic air tunnel, using as its driving fluid steam from a boiler which was available. The cost and time of construction of the unit was, therefore, much smaller than would have been involved in the conventional plan of using compressed air as the driving fluid. The tunnel works satisfactorily, and gives a Mach Number of 1·4 for periods of one minute at intervals of six minutes.

Prof. Richards was educated at University College, Aberystwyth, and later at St. John's College, Cambridge. After some two years research work on aircraft structures with the Bristol Aeroplane Co., he transferred to the National Physical Laboratory in 1939. From 1945 until the present time Prof. Richards has been with Messrs. Vickers-Armstrongs at Weybridge, first as chief aerodynamicist and later as assistant chief designer. He has served on several of the committees of the Aeronautical Research Council and has made special visits to the United States to study the development of wind tunnels and other experimental technique. He has this year been awarded the George Taylor Gold Medal of the Royal Aeronautical Society for the best paper of the year. Prof. Richards's wide knowledge of aeronautical science and his experience of applying it to practical design form an excellent foundation upon which future aeronautical engineering education at Southampton will be based. His experience of the personal qualities which are desirable in engineers to be employed on research and technical development of aircraft will also give great advantage to his future college work.

Veterinary Science at Brisbane: Prof. T. K. Ewer

Dr. T. K. Ewer has been appointed to the chair of animal husbandry in the Veterinary Faculty of the University of Queensland and will arrive in Brisbane in August. Dr. Ewer graduated in veterinary science from the University of Sydney in 1938. After graduation he spent nine years in New Zealand teaching and doing experimental work in animal husbandry at Lincoln Agricultural College, Christchurch. During the past two and a half years he has been investigating the metabolism of phosphorus and vitamin D in sheep in the Department of Animal Pathology, Cambridge, for which work he was awarded the degree of Ph.D. in 1949.

The Veterinary Faculty of the University of Queensland was first established in 1936; but teaching ceased in 1942. In 1946 teaching was resumed for the three preclinical years, and Prof. Ewer's appointment is the first move to re-establish the full five-year course. This chair is of special significance in being the first in animal husbandry in Australia, and its creation suggests the main direction in which the Queensland Veterinary School may be expected to develop. It is of interest to note that veterinary schools in South America are said to have recently re-organised their courses to give greater emphasis to animal production than to medicine. The requirements of the livestock industries in South America and Queensland obviously have much in common, so it is not surprising to see the same trends in veterinary education developing independently in these widely separated countries.

University of Nottingham: First Congregation

On July 11, the University of Nottingham held its first congregation for the conferment of degrees. At the beginning of an impressive ceremony the chancellor, Lord Trent, delivered an address to the graduands. After pointing out the significance of the occasion, he went on to discuss the need and the opportunities for university graduates to engage in business, not only on the scientific and technical branches, but also on the administrative side. There were no honorary degrees, but a few official degrees were conferred, including that of M.A. upon Prof. Janko Lavrin, head of the department of Slavonic languages, for his books on Russian literature, and that of M.Sc. on Mrs. Nora McDermott, of the Faculty of Agriculture, for her work on potato trials. Of the 260 other degrees, the most noteworthy was the award of a D.Sc. to Dr. F. L. Rose, a former student of the University (then University College) and now of Imperial Chemical Industries, Ltd., who was the leader of the research team which, during the War, produced 'Paludrine', the well-known anti-malarial drug.

The Tensor Club of Great Britain

The Tensor Club of Great Britain has been formed with the intention of putting engineers interested in tensor analysis into touch with one another, and, at the invitation of the organisers, Gabriel Kron has become patron. The Club has the following four specific objects that later may be extended: to enable each member to keep his fellow members informed of any work he is doing or proposing to do of interest to the Club; to ensure that the attention of all members is directed to any publication of interest to the Club that comes to the notice of any one of them; to provide a channel for the exchange of ideas and information, and to give individual help and advice when requested; and to promote the extended and increasing use of the techniques developed by matrix and tensor methods. The Club's activities—in the early stages, at least—will necessarily be confined to furthering its objects by correspondence. Membership is open to all those who are actively interested in determinants, dyadics, matrices or tensors, and their application to engineering, wherever they may reside. There is no entrance fee; members pay an annual subscription of one guinea, and associate members half a guinea. Prospective members and others who are interested should write to either of the Club's organisers, S. Austen Stigant, 7 Courtlands Avenue, Hayes, Kent, and W. J. Gibbs, 53 Hillmorton Road, Rugby.

Impact

Unesco has just issued the first of a new bulletin of abstracts concerned with the international and social implications of science. The bulletin, *Impact*, will be published quarterly. The first issue contains an introductory statement on how science impinges on society and a bibliography giving details of the more important publications in English which have already appeared. Future issues will contain abstracts from the publications of other countries dealing with the effects of science on society. The first issue also contains the report of an address by Dr. P. Brandt-Rehberg at the University of Copenhagen on "Science and Society", the report of an address by Dr. S. Tovborg-Jenson on world food problems, an address by Mr. Edmund W. Sinnott to the American Association for the Advancement of Science on the study of science by the amateur as well as one on the "Encouragement of Science" by Dr. J. R. Oppenheimer. *Impact* may be obtained from the Natural Science Department, Unesco, 19 Kleber Avenue, Paris 16, price 2*s*. 6*d*.

Industrial Fluorosis

MEMORANDUM No. 22 of the Medical Research Council, entitled "Industrial Fluorosis" (pp. 131 + 13 plates; London: H.M. Stationery Office, 1949; 4*s*. net), is a report made by the Fluorosis Committee of the Council. Its contents cannot be summarized in detail here; but it records a study of possible effects upon man and animals of the large amounts of fluorine liberated from a factory near Fort William, Scotland, engaged in the manufacture of aluminium by an electrolytic process. Part 1 of the report discusses the contamination by fluorine compounds of the area studied; Part 2 the effects of fluorine compounds on animals in this area; Part 3 the clinical, radiological, hæmatological and biological studies of human beings; Part 4 the dental condition of adults and school children in the area; and Part 5 the physical properties of bone in fluorosis. Appendixes, which summarize the literature on the toxicity of fluorine compounds and describe the analytical methods used, and the bibliography extending to more than four pages of small type, add to the value of this comprehensive study.

Wounds of the Extremities during the War

THE *British Journal of Surgery* is publishing, in four supplements, a permanent record of the achievements of British surgeons during the Second World War. "War Surgery Supplement No. 1" appeared in 1947 and dealt with "Wounds of the Head" (see *Nature*, 161, 635; 1948). No. 2, edited by H. J. Seddon (pp. 261–347; Bristol: John Wright and Sons, 1949. 12*s*. 6*d*.) bears the sub-title "Wounds of the Extremities", and it maintains the very high standard of the preceding supplement. An outstanding feature of these supplements is the excellence of the photographic and coloured illustrations; and the text, although it is addressed mainly to surgeons, will also interest others. Supplement No. 2 deals with war injuries of the extremities in the forward areas of battle, missile wounds involving bone, the early treatment of penetrating wounds of joints, and war injuries of peripheral nerves and arteries. The methods used and the remarkably successful results obtained by modern surgery will interest anatomists and physiologists as well as surgeons. The other two supplements, which will deal with abdomino-thoracic wounds and plastic surgery respectively, should prove equally interesting. It is good to know that the skill of the surgeon is being recorded permanently in this remarkable series of publications.

New Methods of Glasshouse Fumigation

THREE modern methods of pest control by fumigation are reviewed by Mr. G. Fox Wilson in a recent short paper (*J. Roy. Hort. Soc.*, 74, Pt. 10; 1949). Insecticidal smokes, produced by igniting pyrotechnic mixtures containing DDT, 'Gammexane' or 'Azobenzene', provide a very convenient method, but are apt to damage plant foliage near the generator. The amount of insecticide, which condenses upon the leaves is not, moreover, by any means standard. Production of aerosols by atomization under pressure is also convenient, and probably less toxic to foliage. The use of continuous-flow aerosols, however, provides a very promising and practical method. The insecticide is here evaporated slowly and continuously by electric heat. Mr. Fox Wilson describes the result of trials with such an apparatus at Wisley. Perhaps the outstanding effect was a speedy and effective control, with continuous-flow aerosol DDT, of the greenhouse white fly. Adults of this species died within twenty-four hours, and, though the eggs and nymphal stages were unaffected, the adults were destroyed soon after they were produced. Success was also obtained against mealybug, and, in part, against aphids (which are not generally controlled by DDT), and soft scale. Negative results were recorded against eucalyptus sucker and the carnation tortrix moth.

Summer School in Mathematics at St. Andrews

A MATHEMATICAL summer school was held at St. Andrews during June 30–July 8, under the auspices of a group of mathematicians from the four Scottish Universities. It was attended by about forty university teachers and research students. After an opening lecture by Prof. H. W. Turnbull, on "Algebra and Algebraists", courses of lectures were delivered on "Group Representations", by Dr. D. E. Rutherford, of St. Andrews, on "Linear Associative Algebras", by Dr. W. Ledermann, of Manchester, and on "Topology", by Mr. A. G. Vosper, of Dundee.

1851 Exhibition Scholarships

THE Royal Commission for the Exhibition of 1851 announces the award of Overseas Science Research Scholarships for 1950 to the following: *Canada:* W. L. Davison (Dalhousie University, Halifax, Nova Scotia), for research in geology in the University of Edinburgh; N. R. F. Steenberg (Queen's University, Kingston, Ontario), for research in nuclear physics in the University of Oxford; R. M. Stow (University of Saskatchewan), for research in physical chemistry in the University of Cambridge. *Australia:* F. A. L. Anet (University of Sydney), for research in organic chemistry in the University of Oxford; P. J. Fensham (University of Melbourne), for research in physical chemistry in the University of Bristol; L. M. Jackman (University of Adelaide), for research in organic chemistry in University College, London; P. M. Nossal (University of Adelaide), for research in biochemistry in the University of Sheffield. *New Zealand:* L. S. Wolfe (University of New Zealand), for research in animal physiology and biochemistry in the University of Cambridge. *India:* R. C. Sahney (University of the East Punjab and National Physical Laboratory, Delhi), for research in physical chemistry in the University of Cambridge. *Pakistan:* R. Ahmad (University of the Punjab), for research in chemistry in the University of Cambridge or London. *Republic of Ireland:* S. R. Duff (University of Dublin), for research in organic chemistry in the University of Oxford.

Leverhulme Research Fellowships, 1950

AWARDS for research, tenable for periods up to two years, have been made by the Leverhulme Trustees to the following, among others, for work indicated in brackets: *Fellowships:* Dr. J. M. Lambert, lecturer in botany, Westfield College, University of London (ecological investigations into the vegetation in the region of the Norfolk Broads); Mr. D. B. Scott, lecturer in mathematics, King's College, University of London (applications of modern abstract algebra to algebraic geometry); Prof. A. J. B. Wace, professor of classics and archæology, Farouk I University, Alexandria (Mycenæ and the civilization of the Ægean Bronze Age). *Research Grants:* Dr. C. W. Dixon, lecturer and chief assistant, Department of Preventive Medicine and Public Health, University of Leeds (epidemiology of smallpox and control of variola minor); Dr. V. Elwin, of the Tribal Art Research Unit, India (tribal art in east-central India); B. H. Farmer, St. John's College, Cambridge (pioneer settlement in Ceylon); E. Green, general secretary, Workers' Education Association (present-day apathy to adult education); Dr. J. H. G. Lebon, lately professor of geography, University of Ceylon (origins and development of rural settlement in Scotland); Dr. H. M. Muir-Wood, a principal scientific officer, Department of Geology, British Museum (Natural History) (morphology and classification of Brachiopoda); Dr. D. M. Steven, lecturer in zoology, University of Edinburgh (species relationships of British voles); Mr. J. Walton, education officer, Basutoland (native housing in Southern Rhodesia); Mr. J. W. Wright, inspector of surveys, Sudan Government (hydrology of the Riber Sobat and its relation with the White Nile). Information relating to Leverhulme awards can be obtained from the Secretary, Leverhulme Research Fellowships, 7 Bedford Row, London, W.C.1.

International Physiological Congress

THE Eighteenth International Physiological Congress will be held at Copenhagen during August 15–18. A large part of the programme has been reserved for 'general discussions', which will deal with selected physiological problems. These include: salt and water excretion; thermodynamics of muscle, hormonal control of fat metabolism; transport of substances across cell membranes; physiology of the retina, principles of spinal cord activity; and cardiac output in man. As on previous occasions, it has been necessary to arrange the scientific meetings in several sections which will proceed simultaneously. The Congress is to be followed by a meeting of the Scandinavian Pharmacological Society on August 19, at which the properties of adrenaline, *nor*-adrenaline and related substances will be discussed.

Announcements

SIR JOHN ANDERSON has been elected president for the coming year of the British Standards Institution in succession to Sir William Larke.

THE University of Manchester has conferred the honorary degree of M.Sc. on Dr. W. H. Brindley for industrial and public services. Dr. Brindley, who is librarian of Hardman and Holden, Ltd., Manchester, has been honorary secretary and treasurer of the Manchester Section of the Society of Chemical Industry since 1934, and honorary librarian of the Manchester Literary and Philosophical Society since 1940.

A JAPANESE National Institute of Genetics has recently been established at Misima under the directorship of Dr. Kan Oguma. At present it comprises three departments: (1) Phenogenetic; (2) Cytogenetic; (3) Physiogenetic. It is hoped to cover all branches of genetics, pure and applied, dealing with human, animal and plant material.

THE Second Biennial Congress of the International Union of Leather Chemists' Societies will be held in London during September 10–13, 1951, at Regent Street Polytechnic (Portland Hall Annexe), Great Portland Street, London, W.1, at the invitation of the Society of Leather Trades' Chemists. Further details will be announced in due course.

THE Electronics Section of the Scientific Instrument Manufacturers' Association is holding its annual exhibition and symposium at the Examination Hall, Queen Square, London, W.C.1, during September 5–8. As in previous years, a series of technical papers will be read by specialist scientific workers and engineers. Also, there will be a comprehensive display of the latest types of British scientific and electronic instruments. Entrance to the symposium itself will be by ticket of admission (covering also the exhibition), obtainable on application to the Secretary of the Scientific Instrument Manufacturers' Association, 17 Princes Gate, London, S.W.7.

THE Commonwealth Scientific and Industrial Research Organisation has decided to publish a new journal, *Australian Journal of Marine and Freshwater Research*, as a medium for the publication of research papers on the results of original investigations on sea, estuarine, and freshwater fisheries and cognate subjects. It will not appear regularly, but as material becomes available. However, it is expected that two issues of the *Journal* will be published each year; each issue will cost 7*s*. 6*d*. per copy. Correspondence should be addressed to the Secretary, Commonwealth Scientific and Industrial Research Organisation, 314 Albert Street, East Melbourne, C.2.

DR. F. S. STEWART, assistant and lecturer in bacteriology in Trinity College (University of Dublin), has been appointed to the chair of bacteriology and preventive medicine in the College, in succession to Prof. J. W. Bigger, who retires at the end of September. Dr. Stewart, who is thirty-five, was educated at Wesley College and at Trinity College, Dublin. He distinguished himself first in philosophy, turning later to medical studies. He has published papers on *Rh* immunization and on the antigenic modification of red cells by periodate.

THE McCharles Prize of 1,000 dollars, which is awarded periodically by the Canadian Institute of Mining and Metallurgy "for the discovery or improved development of new life-saving devices in the power and light industry, or for any notable achievement in scientific research in any useful practical line", has recently been presented to Christian Lapointe, of the Radioactivity Division, Mines Branch, Ottawa. The award, together with a medal, has been made to Dr. Lapointe in recognition of his researches on the measurement, concentration and extraction of uranium from its ores. Notable among the inventions originating from these researches is the Lapointe picker, an ore-picking belt controlled by Geiger counters, by means of which high-grade pitchblende concentrates are automatically prepared from the uranium ores mined at Great Bear Lake.

ERRATUM. In *Nature* of July 1, p. 17, column 2, paragraph 2, for "International Council of Biological Unions" read "International Council of Scientific Unions".

ISOELECTRONIC REACTIONS IN CONJUGATED SYSTEMS

By Dr. H. C. LONGUET-HIGGINS
Department of Chemistry, University of Manchester

Introduction

ALTHOUGH open to various theoretical objections, molecular orbital theory provides the only practicable method of calculating resonance energies and electron distributions in large molecules. Even so, in order to apply the theory to a large molecule, it has hitherto been necessary to solve sets of simultaneous linear equations; and this process is too lengthy to be undertaken by many organic chemists.

We shall here describe a new and very simple way in which molecular orbital theory can be used for the calculation of differences in unsaturation energy (that is, the energy of the π-electrons) between isoelectronic molecules, and differences in activation energy between isoelectronic reactions. (The word isoelectronic, here and later, is to be understood to refer to the π-electrons only; in this sense pyridine is isoelectronic with benzene.) This new technique avoids the necessity of setting up any secular equations, and can be applied without difficulty to very large systems.

Differences in Unsaturation Energy

Every conjugated organic molecule is isoelectronic with some hydrocarbon molecule or ion, real or hypothetical. Thus glyoxal is isoelectronic with butadiene, and aniline and phenol are isoelectronic with the benzyl anion. Let us denote by E the unsaturation energy of any given heteromolecule, and by E^0 that of the isoelectronic hydrocarbon. Then it can be shown by first-order perturbation theory that

$$E - E^0 \simeq \sum_r \alpha_r q_r^0, \tag{1}$$

where α_r is an energy parameter associated with position r in the heteromolecule, and q_r^0 is the π-charge at the corresponding position in the isoelectronic hydrocarbon. The sum is taken over all conjugated atoms in the heteromolecule. The parameter α_r is usually assumed to depend only on the atomic number of atom r and its nearest neighbours; it is correlated with the difference in ionization potential between atom r and unsaturated carbon. Equation 1 is valid only if (i) α_r is small at all positions r, and (ii) corresponding bonds in the heteromolecule and the parent hydrocarbon have equal resonance integrals. These conditions are fulfilled in molecules containing only C, H and N; and in halogen compounds conjugation involving the halogen p-electrons may be neglected, to a good approximation. However, for organic molecules containing oxygen atoms, equation 1 is unfortunately rather a poor approximation.

Calculation of π-Charges

In order to obtain absolute values of $E - E^0$ from equation 1 it is necessary to know the parameters α_r and the π-charges q_r^0. The former are always the greatest single source of uncertainty in molecular orbital calculations; but if it is only required to know relative values of $E - E^0$ in isomers, this is not a severe limitation, because the charges q_r^0 can usually be found without difficulty.

The most important systems for which q_r^0 can be simply calculated are alternant hydrocarbons (that is, hydrocarbons with no odd-membered unsaturated rings) of the following types:

(1) Molecules or radicals, in which the number of π-electrons equals the number of conjugated carbon orbitals;

(2) Carbonium ions in which the number of π-electrons is even, the number of conjugated orbitals being one greater; and

(3) Carbanions, in which the number of π-electrons is even, the conjugated orbitals being one fewer.

Coulson and Rushbrooke[1] showed that in hydrocarbons of class (1) the π-charges are unity at every position; that is

$$q_r^0 = 1. \tag{2}$$

Now an ion of class (2) is derived from a radical of class (1) by taking away the odd electron; and an ion of class (3) is obtained from a radical of class (1) by putting another electron in the same molecular orbital as the odd electron. It follows that the π-charges in carbonium ions are given by

$$q_r^0 \neq 1 - c_r^2, \tag{3}$$

and in carbanions by

$$q_r^0 = 1 + c_r^2, \tag{4}$$

where c_r is a coefficient the square of which gives the chance of finding the odd electron in the radical on atom r.

It will be shown in a forthcoming article[2] that the following rules give the coefficients c_r for a hydrocarbon radical with $2m + 1$ conjugated atoms.

(*a*) Draw any one of the principal resonance structures of the radical. Then provided the radical has just one unpaired electron, this structure will have just one trivalent carbon atom.

(*b*) Mark this atom with a star and every alternate conjugated atom throughout the molecule. When this process is complete there will be found to be $m + 1$ starred atoms and m unstarred atoms.

(*c*) Assign c_r the value zero for all the unstarred atoms.

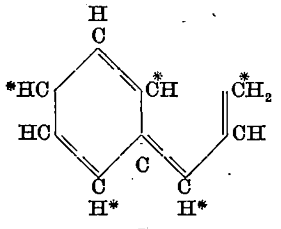
(*d*) For each unstarred atom the sum of the coefficients c_r at the neighbouring starred atoms must be zero. Therefore, if c_r is assigned the value x at a particular atom, the values of c_r at the other starred atoms may be found directly in terms of x.

(*e*) The absolute magnitudes of the numbers c_r are determined by the condition that

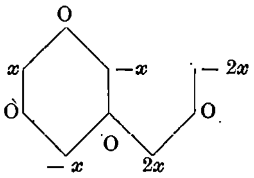
$$\sum_r c_r^2 = 1. \tag{5}$$

As an example we shall calculate the π-charges in the phenylallyl anion. Formula I (p. 140) gives one of the principal resonance structures of the phenylallyl *radical*. The starring process gives five starred and four unstarred atoms. The coefficients c_r vanish at the unstarred atoms; and if c_r is assigned the value x at the *para*-position in the phenyl group, rule (*d*) may be used to write down the values of c_r at the other starred positions (see formula II). By condition (*e*),

$$\sum_r c_r^2 = 11x^2 = 1;$$



I



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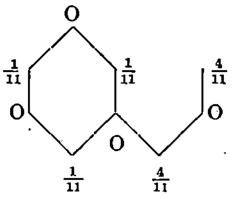
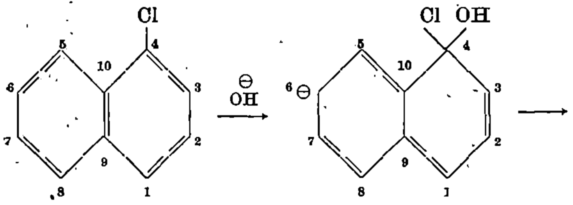


III

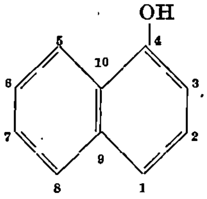
so the absolute values of c_r^2 are as given in formula III. By equations (3) and (4) these numbers also give the net positive and negative charges in the phenylallyl cation and anion. (It may be verified that if c_r had been assigned the value x at the CH_2 group, for example, the final result would have been just the same.)

Differences in Activation Energy

As one example to show how these ideas may be used in computing differences in activation energy, we shall discuss the hydrolysis of various 4-chloro-aza-naphthalenes, some of which have been studied recently by Morley, Simpson and their collaborators[3]. The general mechanism of these reactions is probably as follows:



IV V



VI

(Only one possible resonance structure has been drawn for each species.) In calculating unsaturation energies, it is probably a fair approximation to neglect the conjugation of the Cl atom with the aromatic residue in (IV) and also hyperconjugation involving position 4 in (V). Further, replacement of a particular CH group by N will affect the skeletal energies of (IV) and (V) to roughly equal extents; so any change in activation energy produced by aza-substitution may be ascribed to changes in unsaturation energy of the reactant and transition complex.

Let us denote the unsaturation energy of an aza-derivative of (IV) by E and that of the corresponding transition complex by E'. Then it is assumed that the difference in activation energy between the hydrolysis of (IV) and its aza-derivative is given by

$$\Delta U - \Delta U^0 \neq (E' - E) - (E^{0\prime} - E^0),$$

where E^0 and $E^{0\prime}$ are the unsaturation energies of (IV) and (V) respectively. But by equation (1)

$$E' - E^{0\prime} \neq \sum_r \alpha_r q_r^{0\prime}$$

and

$$E - E^0 = \sum_r \alpha_r q_r^0,$$

where α_r is the energy parameter for position r in the derivative and its transition complex, and q_r^0 and $q_r^{0\prime}$ denote the π-charges at position r in (IV) and (V) respectively. Therefore,

$$\Delta U - \Delta U^0 = \sum_r \alpha_r (q_r^{0\prime} - q_r^0). \qquad (6)$$

But $q_r^0 = 1$ at every position in (IV), and $q_r^{0\prime} = 1 + c_r^2$, by equation (5). Therefore, finally,

$$\Delta U - \Delta U^0 = \sum_r \alpha_r c_r^2. \qquad (7)$$

The values of c_r^2 for the complex (V) may be obtained directly from formula III, since (V) is isoelectronic with the phenylallyl anion. The parameters α_r will have values depending on which CH groups in (IV) are replaced by N. If it is assumed[4] that aza-substitution at position r produces a perturbation δ at that position and a perturbation $\delta/3$ at neighbouring positions, then the values of α_r in the aza-derivatives under consideration will be as given in the accompanying table.

In the extreme right-hand column are given the values of $\Delta U - \Delta U^0$, computed from equation (7) using the assumed values of α_r and the numbers given in formula III. These figures show that 4-chloro-aza-naphthalenes should be increasingly easily hydrolysed in the order

$$A \ll C < B, D \ll E, G < F.$$

Morley and Simpson have recently shown that the 4-chloro-derivatives of quinoline, cinnoline and quinazoline are hydrolysed to the phenols under conditions

		α_1	α_2	α_3	α_5	α_6	α_7	α_8	α_9	α_{10}	$\Delta U - \Delta U^0$
A	4-chloronaphthalene	0	0	0	0	0	0	0	0	0	0
B	4-chloro-1-aza-naphthalene (4-chloro-quinoline)	δ	$\delta/3$	0	0	0	0	0	$\delta/3$	0	$12\delta/33$
C	4-chloro-2-aza-naphthalene (4-chloro-isoquinoline)	$\delta/3$	δ	$\delta/3$	0	0	0	0	0	0	$8\delta/33$
D	4-chloro-3-aza-naphthalene (1-chloro-isoquinoline)	0	$\delta/3$	δ	0	0	0	0	0	0	$12\delta/33$
E	4-chloro-1 : 2-diaza-naphthalene (4-chloro-cinnoline)	$4\delta/3$	$4\delta/3$	$\delta/3$	0	0	0	0	$\delta/3$	0	$20\delta/33$
F	4-chloro-1 : 3-diaza-naphthalene (4-chloro-quinazoline)	δ	$2\delta/3$	δ	0	0	0	0	$\delta/3$	0	$24\delta/33$
G	4-chloro-2 : 3-diaza-naphthalene (4-chloro-phthalazine)	$\delta/3$	$4\delta/3$	$4\delta/3$	0	0	0	0	0	0	$20\delta/33$

in which 1-chloro-naphthalene would certainly not be hydrolysed. Their experimental results give the order

$$A \ll B \ll E < F.$$

Discussion

A more detailed exposition of the ideas outlined, together with a discussion of their validity and range of application in organic chemistry, is shortly to appear in the *Journal of Chemical Physics*. Suffice it to say here that calculations of this elementary nature can be applied to a wide range of organic reactions, and that the results can be proved to be consistent with those of classical electronic theory, provided no odd-membered rings are present. It is scarcely necessary to point out that the present quantitative theory suffers from the same limitations as the qualitative resonance theory, in that it takes no account of entropy changes or solvent effects; but the discussion of such phenomena lies beyond the scope of pure electronic theory.

Perhaps the most important feature of this new technique is that it enables the chemist to calculate *quantitatively* differences in reactivity almost, if not quite, as simply as he could previously estimate them qualitatively by resonance theory. Many gaps, of course, remain: we still do not know the parameters α_r for hetero-atoms with sufficient precision; no account is taken of steric factors; and the new technique cannot be applied to odd-membered ring systems. But it seems ideally suited for the prediction of relative rates of isoelectronic reactions in nitrogen heterocycles; and it is to be hoped that before long it will come to be used by experimental workers for interpreting their results and predicting new ones.

I wish to thank Drs. J. S. Morley and J. C. E. Simpson and their collaborators for allowing me to quote their unpublished results, and Prof. M. G. Evans for his valued encouragement.

[1] Coulson, C. A., and Rushbrooke, G. S., *Proc. Camb. Phil. Soc.*, **36**, 193 (1940).

[2] Longuet-Higgins, H. C., *J. Chem. Phys.* (in the press).

[3] Morley, J. S., and Simpson, J. C. E., *Nature*, **164**, 105 (1949); *J. Chem. Soc.* (in the press).

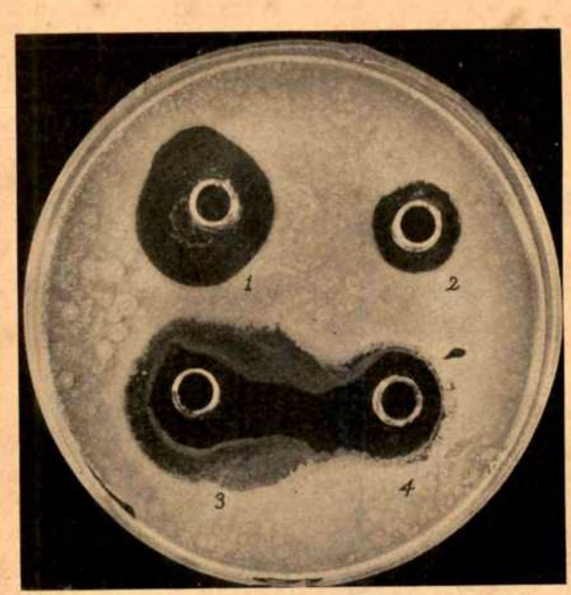
[4] Dewar, M. J. S., *J. Chem. Soc.*, 644 (1949).

ANTIBACTERIAL ACTIVITY OF A SUBSTANCE PRESENT IN TICKS (IXODOIDEA) OF TEXAS

By PROF. LUDWIK ANIGSTEIN,
DOROTHY M. WHITNEY and DON W. MICKS
Department of Preventive Medicine and Public Health,
University of Texas Medical Branch, Galveston

EXCEPT for the biological vectors of specific pathogenic agents, arthropods as a group harbour a great variety of non-specific bacteria[1]. Among the factors influencing the type of bacterial flora, the feeding habits of the arthropod are of primary importance. In this regard the blood-sucking species occupy a singular position as having the fewest bacteria, or even showing sterility of the digestive tract[1].

The present study developed from our recent inquiry into the prevalence of rickettsial infections in 'wild' ticks of the Gulf area and from a bacteriological survey of these ticks. The scarcity or absence of bacterial organisms in the ticks stimulated us to investigate the underlying causes of this phenomenon, inasmuch as Duncan[2] by his original observations first indicated the presence of a bactericidal principle in insects and ticks.



Growth inhibition of *B. subtilis* by trypsin-digested extracts from *Ornithodoros turicata* as compared with the action of the antibiotic *Q* 19 ('circulin'). 'Penicylinder' assay technique
1, *Q* 19 ('circulin'); 2, extract from unfed ticks; 3 and 4, extract from engorged ticks

Hard and soft ticks of Texas (*Amblyomma americanum*, *A. cajennense*, *Rhipicephalus sanguineus*, *Ornithodoros turicata*, *Argas persicus*) in the adult stage were investigated in the search for possible antibacterial properties. Parallel experiments were conducted with unfed and blood-engorged specimens, the latter feeding on cattle, guinea pigs, dogs, rats and chickens.

Aqueous extracts from ground tissues of pooled ticks were reconstituted from the previously lyophilized material on the basis of 0·1 gm. dry weight in 5·0 ml. of phosphate buffer (pH 7·8). This was followed by digestion with trypsin, which proved essential, particularly in handling the high-protein content of engorged ticks. In a series of experiments non-digested material was used for comparison. Prior to final tests, all samples were heated to 65° C. for 30 min.

As a representative test organism, *B. subtilis* was chosen for routine antimicrobial assays. In addition, other spore-bearing bacilli (*B. mesentericus*, *B. megatherium*, *B. cereus*, *B. anthracis*), as well as *Sarcina lutea*, *Staph. aureus*, *Staph. albus* and *Esherichia coli*, were tested. For qualitative and quantitative evaluation of activity of the tick extracts, some methods of the modern antimicrobial assays were applied: streak agar plates, paper disks, 'penicylinders', serial broth dilutions and spot dilutions on agar plates.

The first indication of antibacterial properties was obtained from the unfed *Amblyomma americanum*, dragged from ground vegetation of a heavily infested area. A complete or partial inhibition of growth of *B. subtilis* was demonstrated after placing a drop of tick extract on streaks of the spores. This phenomenon, constantly observed with extracts of the various engorged ticks, occurred with less frequency

Quantitative Evaluation of Antibacterial Activity of Various Ticks against *B. subtilis*

Material	Two-fold serial transfers of crude tick extracts in broth. End-points in decreasing concentrations								
	1 : 50	1 : 100	1 : 200	1 : 400	1 : 800	1 : 1600	1 : 3200	1 : 6400	1 : 12800
Amblyomma americanum engorged and digested	+	+	+	+	+	+	+	+	−
Same, not digested	+	+	+	+	+	+	−	−	−
A. cajennense engorged and digested	+	+	+	+	+	+	+	−	−
Same, not digested	+	+	+	+	+	+	−	−	−
Rhipicephalus sanguineus engorged and digested	+	+	+	+	+	+	+	+	−
Same, not digested	+	+	+	+	+	−	−	−	−
Ornithodoros turicata engorged and digested	+	+	+	+	+	+	+	+	+
Same, not digested	+	+	+	+	+	+	+	−	−
O. turicata unfed digested	+	+	+	+	+	+	−	−	−
Same, not digested	+	+	+	+	+	−	−	−	−
Trypsin alone in broth incubated at 37° C.	−	−	−	−	−	−	−	−	−

+, complete inhibition of growth; no visible growth of *B. subtilis*. −, no inhibition of growth; normal growth of *B. subtilis*.
First tube contains 10 mgm. dehydrated crude extract in 0·5 ml. broth. Readings after 24-hr. incubation at 37° C.

when unfed specimens were used; however, the antibacterial activity of unfed *A. americanum*, *A. cajennense* and *O. turicata* was established by the various antimicrobial assay methods. The antibacterial activity of *O. turicata* (vector of relapsing fever in Texas) was exceptionally high, showing complete inhibition of *B. subtilis* as demonstrated in serial dilutions up to 1 : 12,800 (see table) and on flooded agar plates by extensive clear zones surrounding 'penicylinders' filled with the digested extract (see illustration). Similar results were obtained with *Argas persicus* collected from chicken houses; a bacteriostatic or bactericidal agent was found in this species by E. A. Steinhaus in 1943 (personal communication). In this series clear, bacteria-free spaces on agar plates resulted from contact with the proteolytic products, whereas the non-digested portion of the same material showed no activity. It should be emphasized that tryptic digestion of the tick material is indispensable not only for the liquefaction of the viscous, coagulated, bloody content of the ticks, but, as previously observed by Duncan[2], was found to intensify growth inhibition (see table).

Having no data as to the nature of the digestive enzymes of ticks, we can only presume that they resemble those of insects, the enzymes of which are adapted to their particular diet[3]. We may, therefore, anticipate that in ticks feeding exclusively on blood, protease is produced in abundance. Since protease of insects is of the tryptic type, the addition of trypsin as an extrinsic but homologous factor merely led to the continuation of enzymatic hydrolysis by the tick. It is therefore logical to assume that the chemical nature of the antibacterial substance (single or multiple) lies within the range of these proteolytic products.

Preliminary tests to determine the range of the antibacterial properties of the active principle showed a spectrum limited to *B. subtilis*, *B. mesentericus*, *B. megatherium*, *B. cereus* and *Sarcina lutea*.

Some other properties of the antibacterial substance have been determined. It resists dehydration *in vacuo* and remains active in a dry state when kept in air-filled sealed ampoules for at least several months in the refrigerator. It resists heat to 121° C. for 15 min. in liquid medium at *p*H 7·8–9·4, but the antibacterial factor is destroyed by heat at *p*H 5·7 or lower.

The higher activity of the material from engorged ticks suggested that blood may be the source of an additional antibacterial factor. For preliminary tests, guinea pig blood was used, since in a series of experiments this animal served as host of *Amblyomma americanum*. The blood was divided in two main portions: one was coagulated, while the other was defibrinated mechanically and centrifuged. Serum was separated from the cells, which were washed in sterile saline. Each component was lyophilized and either digested with trypsin or left untreated.

A total of ten blood samples was examined in various combinations, heated to 65° C. for 30 min. A complete inhibition of *subtilis* growth was noted on agar plate streaks with trypsin-digested cells and partial inhibition with digested whole blood. However, a complete absence of antibacterial activity of the fresh or heated serum was noted, which is of interest since the serum of various animals is known to contain non-specific thermostable substances such as beta lysins[4]. It is to be observed that the antibacterial properties of the blood were demonstrated by us only when proteolysis was applied. This would suggest that the antibacterial activity of the digested cells is associated with the enzymatic hydrolysis of proteins and liberation of peptides and perhaps free amino-acids. Independently, and at our request, the chemical nature of a sample representing desiccated material from engorged *A. americanum* has been investigated by Dr. Jorge Awapara, of the University of Texas, M. D. Anderson Cancer Research Hospital, Houston. The results of this work suggested that there were very few amino-acids and only one peptide detected in the crude tick extract. This peptide (*Y*) was stated by Dr. Awapara to be similar to or identical with the one found by him in human blood (personal communication).

Since the antibacterial factor found in ticks is considerably enhanced by the ingested mammalian blood, the question arises whether this phenomenon may have some bearing on the 'reactivation' of spotted fever rickettsiæ in Nature as formulated by Spencer and Parker in 1923[5]. In reviving this almost forgotten theory, the ingestion of fresh blood is, according to these authors, essential to transform the non-virulent phase of the 'virus' of the unfed infected ticks to a virulent fever-producing phase. Some unrecognized condition initiated by the ingestion of blood was assumed to play a part in this transition, which in our interpretation may be due to metabolic processes of the vector, inasmuch as *Dermacentor andersoni* requires up to forty-eight hours of attachment to the host to become infective. In the light of our observations this "unrecognized condition" might be caused by the enzymatic hydrolysis of blood proteins creating in the tick environmental factors unfavourable to bacteria, but suitable to the different metabolic requirements of parasitic rickettsiæ.

This work was aided by a grant of the Lilly Research Laboratories. An account of it was presented at a meeting of the Texas Branch, Society of American Bacteriologists, November 19, 1949, Austin, Texas.

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INTERNATIONAL CONVENTION ON ULTRASONICS

THE International Convention on Ultrasonics, held in Rome during June 14–17, represented a milestone in the progress of ultrasonics and was an achievement in many respects. There were about one hundred and twenty delegates from fourteen different countries, including Great Britain, the United States, France, Italy, Germany, Belgium, Holland and Switzerland. The Convention was organised by the Consiglio Nazionale delle Ricerche and the Societa Italiana di Fisica, supported by the International Union of Pure and Applied Physics and by the United Nations Educational, Scientific and Cultural Organisation. As was widely attested by delegates, much credit was undoubtedly due to Prof. A. Giacomini, director of the O. M. Corbino Institute of the Italian National Research Council, for the inspiration and planning of the Convention. The arrangements were admirable and the programme was carried out smoothly and expeditiously.

After an impressive official opening of the Convention at the Protomoteca Hall at the Capitol, with speeches by the Mayor of Rome, Prof. G. Colonnetti (president of the Italian National Research Council), Prof. P. Fleury (secretary of the International Union of Pure and Applied Physics) and Prof. Giacomini, the scientific proceedings took place in the O. M. Corbino Institute, a well-designed modern building comprising laboratories, offices, library and auditoria. The first paper gave a general account of the present ultrasonic work[1] at the Institute and the plans for future work there. Several of the applications described arose from the ultrasonic grating method of light control, this method being used for communication systems involving modulation of light beams, for accurate measurement of velocity in liquids, measurement of Poisson's ratio in solids and for demonstration of acoustic lenses, while a possible use for flaw detection was forecast. Other activities included an ingenious use of a simple microphone for measurement of pulsed ultrasonic radiation, and work on elastic constants and anelasticity of metals using ultrasonic vibrations.

Among the main representatives were Prof. F. E. Fox (United States), Dr. L. Bergmann (Germany), Dr. F. Canac (France), and Prof. A. van Itterbeek (Belgium), and among other well-known workers in the field of ultrasonics were: Messrs. Biquard, Grabar, Lucas, Prudhomme, Kneser, Schaafs, de Groot, R. Pohlmann and P. Bordoni. The delegates from Great Britain were Messrs. Bell, Bradfield, Crawford, Hillier, King, Pickles, Stephens and Stanford. The Convention was so well attended that, apart from combined sessions for subjects of common interest, it was found necessary to use two auditoria simultaneously, in one of which subjects mainly of interest in physics and technology were discussed, and in the other, applications to biology and medicine. In this way, time was found for a total of ninety communications to be made in the period of four days.

After Dr. J. W. F. Bell had given a brief account of the work[2] at Newcastle upon Tyne on errors in interferometry, the behaviour of carbon dioxide and ethylene near their critical points, and absorption in tubes, Dr. Bergmann, author of "Der Ultraschall"[3], gave an excellent survey of progress in ultrasonics, in the course of which he illustrated the Kelvin–Hughes and the Sperry ultrasonic flaw detectors, the American smoke-precipitating sirens and the Mullard ultrasonic soldering iron. Messrs. Chavasse and Lehmann then gave an account of the measurement and analysis of ultrasonic vibrations met in everyday life in aircraft engines and electric drills, and those emitted by insects.

In the fundamental field of physics, emphasis was laid on the value of ultrasonics for precision measurement of velocity, accuracies of 0·05 per cent being achievable; even in small specimens a few millimetres in length, 1 per cent accuracy is readily possible. The investigation of absorption in liquids is yielding valuable results on relaxation phenomena, and it seems possible that the association bonding energies of such organic components as acetic and propionic acids may be revealed by these means. Collision phenomena causing high absorption in binary liquid mixtures are being thoroughly investigated.

Relaxation phenomena in solids of the type discussed by Kê[4] involving viscous slip at grain boundaries are being investigated at temperatures near the melting point of, for example, aluminium, using ultrasonic frequencies. Measurements of piezoelectric and dielectric properties of materials such as barium titanate seem likely to provide valuable information on dipole properties in solids. The Bergmann–Schäfer technique for measuring elastic properties is now being successfully employed on transparent piezo-electric materials, including those of the ferro-electric type.

The complications arising when cavitation is present during ultrasonic propagation were emphasized. It was pointed out that if liquids are freed from air bubbles and other nuclei, cavitation does not take place; but at the same time the ability to produce emulsions and the lethal action on bacteria are much reduced. These effects seem to depend on the intense shock waves arising when cavitation voids collapse.

In technology the value of ultrasonic testing for flaws was emphasized, and experience of its use for many years in the aluminium industry was summarized. Success has been claimed for the ageing of spirits, for example, whisky, by ultrasonic irradiation. The usefulness of ultrasonic irradiation in the soldering of metals such as aluminium is now well established. An interesting attempt was described to forecast by a model test using ultrasonics the performance at audible frequencies of an open-air theatre.

The widespread use of ultrasonics in biological investigation and in therapy is noteworthy. It appears that many hundreds of ultrasonic equipments for medical purposes costing £100–£400 apiece have been manufactured and are in use on the Continent of Europe. In contrast, it seems doubtful whether even a single equipment is used for this purpose in Great Britain. The total amount of equipment involved is probably comparable to that used for ultrasonic flaw detection throughout Europe, and the importance of this field is reflected in the fact that slightly more than 50 per cent of all the contributions to the Convention were on biology and medicine. At the exhibition of ultrasonic equipment which accompanied the Convention, it was noticeable that there was a great variety of therapeutic equipments preponderating over all other types of apparatus, even over that for flaw detection.

In biological applications the nature of the effect of ultrasonic radiation depends markedly on the intensity and on the frequency, which ranges from a few kilocycles to a few megacycles, and perhaps on whether pulsed radiation is employed. There appear to be broadly two effects, a heating effect and a mechanical effect. The former may differ markedly in its distribution from that when infra-red or radio short-wave radiation is used; for heat will be generated by the mechanical waves where absorption is most pronounced, while the depth of penetration will be less the higher the frequency employed. Thermal effects are more marked at high frequencies; but mechanical damage more often occurs at low frequencies.

At lower intensities the mechanical effects of irradiation appear to be to cause acceleration of chemical reactions, liquefaction of thixotropic gels and an increased permeability of cell walls and membranes to the passage of natural fluids. These lower intensities are of the order of ½–3 watts/sq. cm. Above this level, prolonged irradiation causes irreversible changes and can break up the protein molecules themselves, as was shown by the investigations of several biological workers. Examples were cited of the irradiation of embryos, where the use of lower intensities accelerated development whereas higher intensity produced harmful and irreversible effects. The reaction of the nerve cells to radiation seems to involve a relaxation time, for it appears that the effect of stimulation continues even after the stimulus ceases. As a consequence, equipment has been developed which irradiates in successive bursts, the theory being that, while heating is reduced, the slowness of the physiological relaxation diminishes the effect of the gaps in transmission time, so favouring the mechanical effect in comparison with the heating effect.

It is impossible in this brief account to discuss adequately the thirty papers on medical aspects of the use of ultrasonics. Some forty maladies were listed which are believed to have benefited by irradiation. These range from treatment of abscesses, arthritis, asthma, ischias, carbuncles and lumbago to the treatment of neuralgia and spondylarthritis ankylopoietica Bechterew. In general, the intensity used is 1–5 watts/sq. cm., the treatment time varies from two to twelve minutes and the number of treatments from a few up to fourteen. Hundreds of treatments have been systematically examined, and there appears little doubt that benefit often results even in cases which have previously proved most obstinate to alternative treatments.

G. BRADFIELD

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ASTRONOMY IN AUSTRALIA

REPORT OF THE COMMONWEALTH ASTRONOMER FOR 1949

THE report of the Commonwealth Astronomer for 1949* covers the year up to December 31 and is divided into the following sections: solar investigation, time service, astrophysical observations, Melbourne catalogue, 74-inch reflector, 48-inch reflector, workshop, ionospheric prediction service, publications, staff and general. As very full descriptions are given under the different sections, it is impossible to do anything more than notice a few of the more outstanding features in the report.

Time service and astrophysical observations (the latter including seven sub-sections) occupy more than one-third of the report. During 1939 three additional frequency-standards were installed at the Postmaster-General's Research Laboratories, three at the National Standards Laboratory and three at Canberra. Improved methods of forecasting clock errors were introduced, and the radiated signals are now self-consistent to within 2–3 milliseconds a day. Under the heading of astrophysical observations, it is satisfactory to learn that the spectrophotometric gradient observations of brighter stars were completed, and the results for 166 stars have been prepared for publication. The observations have provided increased precision to the blue end of the spectrum-colour relation, as some very blue southern stars were included, and this is important in the study of interstellar reddening and also of the stellar temperature scale. Many will await with interest the publication of the results of the galactic-radio emission at a frequency of 200 Mc./s. on which observations have been made and corrections for aerial beam width applied.

Sir Howard Grubb, Parsons and Co. have the greater part of the heavy components of the 74-inch reflector ready for machining, and arrangements are being made for the contract for the supply and erection of the dome and building. The borosilicate glass disk for the 48-inch reflector has been cast by Messrs. Pilkington Bros., Ltd., and the optical work is in the hands of Messrs. Cox, Hargreaves and Thompson, Ltd. The Observatory workshop has been responsible for a number of major items, including: a three-prism slit spectrograph of dispersion 10 A./mm. at $H\alpha$, which has been mounted in the Reynolds reflector; plate holders; a set of photometric sectors and mountings; and photometric calibrating equipment, constructed for the faint-star magnitude programme. Mirrors have been resilvered, and also adjustments and repairs made to various instruments submitted by Government organisations in Canberra.

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* Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the year 1949. Pp. 6. (Canberra: Commonwealth Government Printer, 1950.)

LETTERS TO THE EDITORS

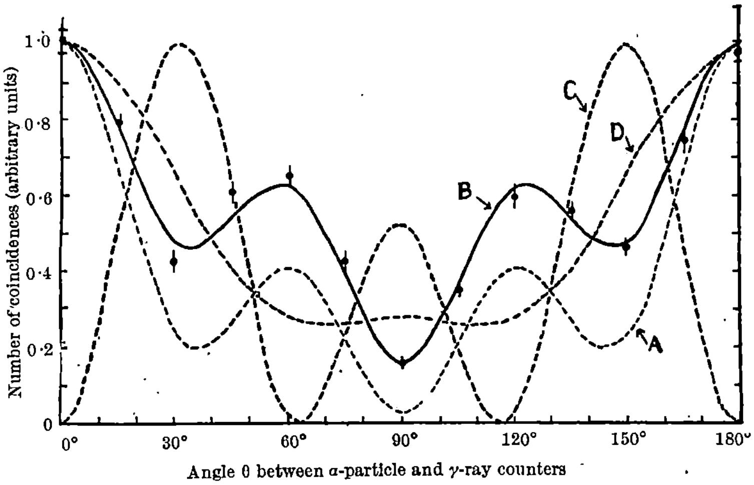
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Angular Correlation Between α-Particles and γ-Rays in the Reaction $F^{19}(p,\alpha\gamma)O^{16}$

WE have studied the correlation between the directions of emission of alpha-particles and gamma-rays at the 340-keV. resonance in the following reaction :

$$F^{19} + p \rightarrow Ne^{20*} \rightarrow O^{16*} + \alpha \rightarrow O^{16} + \gamma + \alpha.$$

Both alpha-particles and gamma-rays were observed in the plane perpendicular to the proton beam. The alpha-particles were detected in a proportional counter with a window sufficiently thick (approximately 6·5 mm. air equivalent) to exclude protons scattered from the calcium fluoride target. The 6·1-MeV. gamma-rays emitted from the oxygen-16* nuclei were detected in a lead-walled Geiger counter. Coincidences between the alpha-particles and the gamma-rays were measured as a function of angle between the counters.



The results are shown by the experimental points in the accompanying graph. It can be seen that there are terms as high as $\cos^6 \theta$ and that there is approximate symmetry about the 90° direction. The presence of a $\cos^6 \theta$ term requires that the orbital momentum l of the alpha-particle and the angular momentum j of the oxygen-16* nucleus must both be at least 3. In order to make a more detailed interpretation, it is first necessary to know the orbital momentum of the incoming protons. Evidence that this is zero is provided by the isotropy (with respect to the incident protons) of the alpha-particles[1] and gamma-rays[2].

If we assign to l and j their lowest possible values, namely, 3, and further assume the total angular momentum $J = 1$ for this resonance-level of neon-20*, we get the theoretical result indicated by curve A. When a correction is made for the finite solid angles subtended by the detectors $(\sim \frac{1}{50} \times 4\pi)$, curve B is obtained. The close agreement between this curve and the experimental results supports the above assignment of angular momenta. The assignment $J = 0$ to the resonance-level which requires j and l to be equal leads for any value of j to an angular correlation function which is zero at $\theta = 0°$ and 180°. This conflicts directly with experiment as illustrated by curve C, which is drawn for $j = 3$. It is therefore impossible to attribute the isotropy of the alpha-particles and gamma-radiation, mentioned above, to a $j = 0$ level of neon-20. Two other feasible interpretations have been examined: (i) $J = 1$, $j = 4$, $l = 3$; this gives curve D. (ii) $J = 1$, $j = 3$, $l = 2,4$. Both components $l = 2$ and 4 can be present without producing terms higher than $\cos^6 \theta$, and we must therefore consider the distribution produced by a coherent superposition of the $l = 2$ and 4 components. By a suitable choice of amplitude and phase relationships between these two components we can, in fact, produce a distribution function which agrees with experiment; but this requires the contribution from $l = 4$ to be at least half that from $l = 2$, which is rather improbable.

We may therefore reasonably conclude that: (i) this resonance level of neon-20 is formed by $l = 0$ protons, has $J = 1$, and is probably of even parity because alpha-particle emission to the ground-state of oxygen-16 is not observed[3]; (ii) since the neon-20* has even parity and is formed by $l = 0$ protons, fluorine-19 also has even parity; (iii) the neon-20* emits alpha-particles with $l = 3$, leaving an excited oxygen-16 nucleus with $j = 3$ and odd parity.

Even parity for the ground-state of fluorine-19, and an excited state of oxygen-16 with $J = 3$, odd parity at 6·1 MeV., are both compatible with the alpha-particle model of the nucleus. The even parity of fluorine-19 is also in agreement with the central field model, which gives for this nucleus the configuration ${}^4S^{12}p^3d$. This model gives for the low excited states of oxygen-16 the configuration ${}^4S^{11}p^1d$, which includes the possible terms ${}^3D_3$, ${}^1F_3$ and ${}^3F_3$, all of the type $j = 3$, odd parity.

A difficulty that arises from these results is the interpretation of the observed width and cross-section of this resonance-level in neon-20. Measurements[4,5] indicate a combined width for alpha-particle and proton emission of 3·2 keV., made up of one width of 40 eV. and the other of 3·16 keV. The larger of these two widths (usually attributed to the alpha-particle) is difficult to reconcile with the small barrier-penetrability to be expected for either protons of such low energy or alpha-particles of such high angular momentum. This may indicate the inadequacy of some of the approximate methods used to calculate penetrability factors for particles of non-zero angular momentum[6].

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Chemical Effects of Ionizing Radiation in some Gels

WE have previously studied the chemical changes produced by radiation in aqueous solutions and especially the use of such changes for radiation 'dosimetry', that is, the measurement of the energy absorption of ionizing radiations[1]. In the search for a suitable system which would enable three-dimensional distributions of absorbed energy to be demonstrated, we have experimented with gels containing dyes which are reduced with change of colour on irradiation. Various phenomena have been observed, apparently bearing also on the biological action of ionizing radiation and perhaps on electron-capture processes in general.

For 'dosimetric' purposes, the system must be quasi-solid, should give a chemical change which is easily observed, and have the same average atomic number and electron density as body tissue (that is, as water). Suitable dyes which have been studied include methylene blue[2] and phenol-indo-2 : 6-dichlorophenol, which are decolorized, and we also observed that Folin's phenol reagent becomes coloured on irradiation. Gelatine or agar were used to form the gel in water, and the concentration of the dye was of the order of 0·001 per cent. The quantitative yields obtained at this low concentration show that the effect is not of a photochemical, but rather of a 'radiation chemical' nature, where almost all the change finally observed in the dye is due indirectly to energy absorbed in the rest of the aqueous system. We have investigated the dependence of the yield on *p*H, concentration of dye and gelling material, and of oxygen and carbon dioxide.

Closely similar changes are observed in gelatine and agar. Oxygen, if present, competes with the dye for the reducing agent. In the case of methylene blue (Fig. 1), there is rather a sharp break in the curve when all the oxygen is reduced[1,3], whereas the indophenol dye (Fig. 2), which has a higher reduction potential, shows a rather more equal sharing of the available reducing agent, giving a more gradual change in the curve when all the oxygen is reduced. In the absence of oxygen and carbon dioxide, the curves are approximately linear until the dye is almost completely reduced. The linearity makes these reactions suitable for the quantitative determination of dose. Comparatively high gelatine or agar concentrations do not appear to compete appreciably with the dye for the reducing agent. This may be compared with the known great radiosensitivity of living tissues and certain enzymes[6].

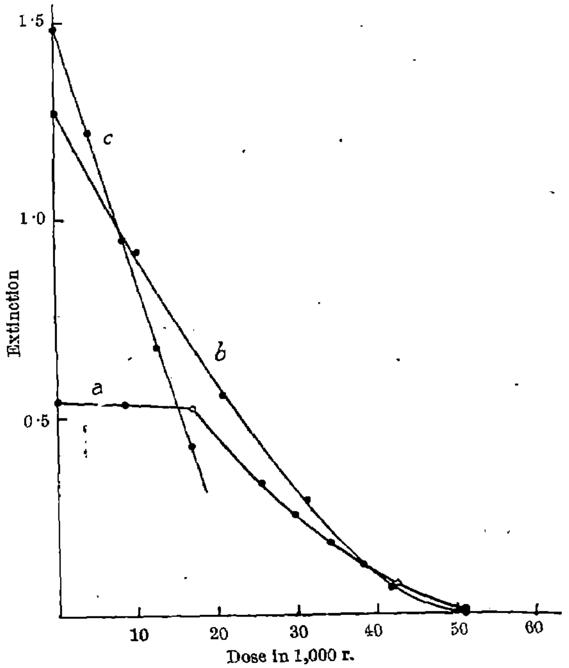

Fig. 1. Irradiation of methylene blue. (*a*) In presence of air; (*b*) in absence of air; (*c*) in absence of air with 1·6 per cent sodium benzoate added

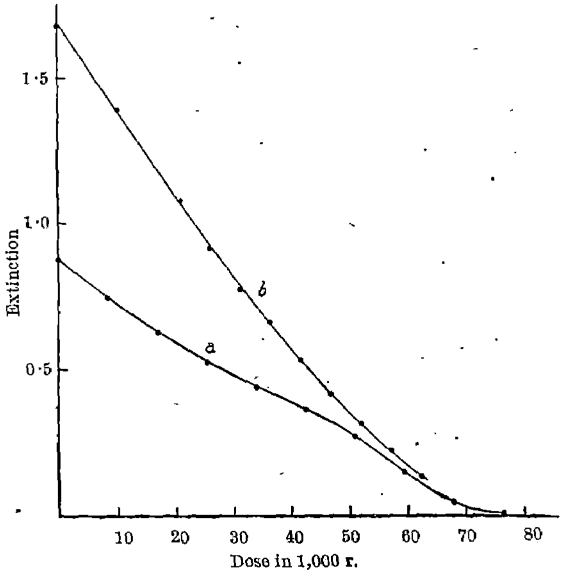

Fig. 2. Irradiation of phenol-indo-2 : 6-dichlorophenol. (*a*) In presence of air; (*b*) in absence of air

The action of radiations on aqueous solutions is considered[4] to proceed by way of a primary ionization.

$$(1)\quad H_2O \longrightarrow H_2O^+ + e,$$

followed by formation of hydroxyl radicals from the the H_2O^+, and

$$(2)\quad H_2O + e \rightarrow H_2O^-,$$

leading to the formation of hydrogen atoms from the H_2O^-.

While this is certainly the case in aqueous solutions in general[5], our results seem to suggest that the additional reactions

$$(3)\quad O_2 + e \rightarrow O_2^-$$

and $$(4)\quad (\text{dye}) + e \rightarrow (\text{dye})^-$$

may compete with reaction (2) for the ionization electrons. The relative extent of these reactions will depend on the various electron affinities, and it is possible that very low concentrations of a suitable acceptor may capture practically all the electrons.

Our view that direct electron capture is playing a part in radiation chemistry may be collated with the findings of other workers that carotene dissolved in anhydrous fat or hexane is decolorized[7], and ferric iron in ether is reduced, by ionizing radiations[8]. Since, however, in these solvents the possibility of hydrogen atoms being formed still exists, we have carried out experiments in carbon tetrachloride and shown, for example, that the indo-phenol dye is reduced. It seems that although the action of ionizing radiation may under certain conditions be entirely due to free radicals, in other cases it may be due, at least in part, to direct electron capture.

We have observed several re-oxidation phenomena, apparently due partly to the hydroxyl radicals and partly to oxygen (produced on irradiation or by diffusion from the air) as well as to O_2^- formed if oxygen is present during the actual irradiation. These effects may be related to certain biological effects of radiation, and may be compared with recent work on the role of O_2 and O_2^- in oxidation processes, involving semiquinones[9].

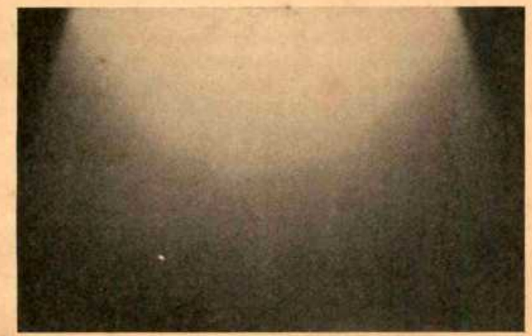

Fig. 3. 200-kV. X-ray beam in tissue-like 'phantom'. Diaphragm defining beam, 11 cm. diameter. Photograph reduced to half linear dimensions

A suitable system for our original purpose of dosage determination consists of 0·003 per cent methylene blue in 1 per cent agar, with the addition of 1 per cent benzoate to capture the hydroxyl radicals and so to increase the yield. Nitrogen, which apparently does not interfere, is bubbled through the hot gel to free it from oxygen, and it is then introduced into an appropriately shaped 'Perspex' vessel and allowed to solidify. Fig. 3 shows the picture obtained by irradiating such a vessel with an X-ray beam. We believe that the method may well find application in the measurement of three-dimensional distributions of absorbed radiation. Since the colour is formed without the addition of further reagents, it may also in some cases be preferable to previous methods for the chemical measurement of radiation.

Full details will be published elsewhere.

We wish to thank Dr. F. T. Farmer and Dr. Joseph Weiss for their support of this work and for many valuable discussions, and Dr. L. H. Gray for helpful suggestions.

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A Correlation of Restoring Coefficients in Molecular Potential Functions and Bond Orders Between the Different Atoms in Polyatomic Molecules

By re-investigating the Raman spectrum of C_2N_2 we have obtained, in addition to the frequencies already known[1], four more frequencies: 521·4 cm.$^{-1}$, 561·4 cm.$^{-1}$, 841 cm.$^{-1}$ and 2298·4 cm.$^{-1}$. The last one, which appears as a weak satellite to the very strong 2328·5 cm.$^{-1}$, is most probably an isotope line due to $C^{12}C^{13}N_2^{14}$, and enables us to calculate the complete harmonic potential function using some infra-red frequencies also[2]. In order to get an interpretation of the physical nature of the potential function, it is helpful to calculate the forces called into action on different atoms i by special atomic displacements. Considering only displacements, Δx, along the axis of the linear molecule, these forces are given by

$$K_{ij} = -\left(\frac{\partial V(x_j)}{\partial x_i}\right)_{x_j = \Delta x}.$$

If the potential function is analysed in this way, the forces between the atoms appear to be independent of the order in which we arrange the two carbon atoms and the two nitrogen atoms along a straight line. Thus it is possible to decide which atoms are most strongly bonded and hence to determine the structural formula, NCCN, without ambiguity.

Restoring coefficients between the atoms i and j defined by

$$k_{ij} = \frac{dK_{ij}}{dx}$$

may be calculated also from the bond orders, p_{ij}, obtained by the method of linear combination of atomic orbitals. According to Coulson[4], the bond order is defined by

$$p_{ij} = \sum_m c_{im}\, c_{jm},$$

where c_{im} is the coefficient of the atomic wave function, φ_i, in the expansion of the molecular function, Φ_m, and the summation is performed for all occupied molecular orbitals. We now assume this definition to be valid also for non-adjacent atoms, thus giving us a measure for the direct interaction forces between the atoms i and j. Further, it seems reasonable to assume the restoring coefficient (k_{ij}, defined as above) to be directly proportional to p_{ij}, but inversely proportional to the distance, d_{ij}, between the two atoms. By applying the formula

$$k_{ij} = k_{ij}^* \cdot \frac{d_{ij}^*}{d_{ij}} \cdot \frac{p_{ij}}{p_{ij}^*},$$

where the starred quantities designate known values taken from one molecule, we are able to calculate the restoring coefficient, k_{ij}, for the direct interaction force between two atoms of the same kind in other molecules. In this way we have calculated the restoring coefficients for the NCCN-molecule (the atoms being numbered 1 to 4) from the known values of the restoring coefficients, interatomic distances, and bond orders in HCN, N_2 and C_2H_2. The accompanying table shows the agreement between the 'spectroscopic' and the 'theoretical' restoring coefficients (given in 10^5 dyne/cm.$^{-1}$).

	k_{12}	k_{13}	k_{14}	k_{23}
k_{ij} from the spectra	+16·58	+1·02	−0·96	+6·24
k_{ij} from the method of linear combination of atomic orbitals	+16·75	+1·05	−1·10	+6·48

Considering the approximate nature of the method of linear combination of atomic orbitals, this surprisingly close agreement must, of course, be regarded as fortuitous. However, calculations based on data given in the literature seem to support the general validity of the proposed relation between bond order and restoring coefficient. It may, therefore, be useful also for calculations of potential functions as for control of approximations used in the method itself.

A detailed report will be published in *Acta Chem. Scand.*

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X-Ray Analysis of the Swelling of Wood Pulp in Sodium Hydroxide Solution

INVESTIGATIONS[1] on the hydrolysis and water-regaining properties of wood pulp, cotton and cotton linters swelled in sodium hydroxide solutions of varying concentrations showed that, whereas for wood pulps a low constant-limit degree of polymerization and high constant water-regain were reached by swelling in an 8 per cent lye, it was necessary to swell cotton and cotton linters in a 10 per cent solution in order to obtain a similar result. These differences between swollen samples of the two fibres might be due to easier mercerizing, that is, transformation of the cellulose I lattice into the cellulose II lattice, in the case of the wood pulp as compared with the cotton linters.

The mercerizing of cotton fibres has been subject to a number of investigations[2,3,4], and at the temperature employed in our work the cotton will show a mixed cellulose I – cellulose II X-ray diffraction pattern when swelled in sodium hydroxide solutions of between 9·5 and 10·5 per cent. Below this range cellulose I, and above this range cellulose II, patterns are observed. Few investigations have been carried out on wood pulp fibres. Katz and Seiberlich[5] found at 18° C. that the mercerizing strength of sodium hydroxide was 15 per cent for cotton and only 11·25 per cent for wood pulps. They claim that fibres with a higher degree of polymerization are more difficult to mercerize than those of lower degree of polymerization, thus accounting for this difference between wood pulps and cotton fibres.

It was thought to be of interest to compare the X-ray diffraction patterns of pulp samples swelled in the range of sodium hydroxide solutions where the rather abrupt changes in the hydrolysis and water-regains are observed. Two sodium chlorite bleached pulps, 1,556 and 1,597, with degrees of polymerization of 1,700 and 1,300, respectively, were swelled in sodium hydroxide solutions varying in concentration between 5·5 and 8·0 weight per cent at 3° C. as described by Jörgensen[1]. For the X-ray diffraction work the fibres were carefully arranged to give complete random orientation and irradiated in a Debye-camera in a hydrogen atmosphere with a copper $K\alpha$ beam.

The X-ray diffraction diagram of pulp 1,556 swelled in 5·5 per cent lye exhibits an unchanged cellulose I pattern, whereas the diagram for that from 6 per cent lye shows partial mercerization. The formation of cellulose II at the expense of cellulose I is indicated from the decrease of the intensities of the 101 and $10\bar{1}$ interferences of cellulose I and from the increase in the intensity of the 121 interference of cellulose I caused by the superposition of the $10\bar{1}$ interference of cellulose II. For samples swelled in 7 and 7·5 per cent lye a steady increase in the amount of cellulose II is indicated by the appearance of the 101 interference of cellulose II and further decrease in the intensities of the 101 and $10\bar{1}$ interferences of cellulose I. The 8 per cent sample exhibits the pure cellulose II diagram.

The mercerizing of pulp 1,597 is retarded as compared with 1,556, as the 6 per cent sample gives an X-ray diagram showing very little change towards cellulose II. Again, the 6·5 and 7·5 per cent samples show diffraction diagrams of the mixed cellulose I and cellulose II patterns, and the 8 per cent sample has a pure cellulose II diagram.

LIMIT D.P., WATER-REGAIN AND X-RAY EVIDENCE FOR WOOD PULPS SWELLED IN ALKALINE SOLUTIONS OF VARYING CONCENTRATIONS

Swelling solution (weight % NaOH)	Pulp 1,556 (D.P. = 1,700)			Pulp 1,597 (D.P. = 1,300)		
	Water-regain (%)	Limit D.P.	X-ray evidence	Water-regain (%)	Limit D.P.	X-ray evidence
0	6·5	240	Cell. I	6·6	225	Cell I
5·5	6·6	140	Cell. I	7·7	115	Cell. I
6·0	8·3	95	Cell. I & II	8·1	75	Cell. I
7·0	8·4	80	Cell. I & II	8·3	75	Cell. I & II
7·5	8·7	75	Cell. I & II	8·7	65	Cell. I & II
8·0	8·8	55	Cell. II	8·8	55	Cell. II

The accompanying table shows that the X-ray analysis of the two pulps is in full agreement with the hydrolysis and water-absorption properties, which are seen to be sensitive indicators of any intracrystalline swelling. Note that the limit degree of polymerization may drop to half its original value without change in the X-ray diffraction pattern.

Wood pulps are undoubtedly more easily mercerized than cotton and cotton linters[1]. This difference cannot be explained on the basis of the lower degree of polymerization of the pulps[5], because the 1,556 pulp had a degree of polymerization similar to that of cotton linters. It seems to be more plausible to base an explanation on a possible difference in crystallite dimensions. The pulp of lower degree of polymerization (1,597) seemed to be more difficult to mercerize partially than the material of higher degree of polymerization (1,556). This indicates that the transition of cellulose I to cellulose II is dependent also upon the intercrystalline network, in that long cellulose chains extending through and connecting the crystallites facilitate the transformation to the cellulose II lattice. Details of this work will be published elsewhere.

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Age of Extremely Ancient Pegmatites from South-eastern Manitoba

In the determination of the geological ages of minerals by radioactivity methods, much attention is being given to those ages which are of the greatest antiquity. There are several reasons for this. The age of the oldest mineral sets a minimum value for the age of the earth; also a probable minimum age is set for the solar system and extra-terrestrial matter in general. A bottom 'rung' is given for any stratigraphical age column, and these great ages are of value when attempting to draw up possible maximum life-spans for the evolution of living organisms to their present state of complexity. In areas of extreme antiquity, suitable minerals may be used for the indirect determination of the decay constants of potassium[1]; furthermore, areas of greatest age are the most suitable places for seeking possible undetected radioactivities (for example, indium-115[2]). Consequently, it is highly desirable that these greatest ages be known accurately and that several checks be made.

Measurements made by the lead method (see discussion of several determinations by Holmes[3]) and the strontium method[4] show the age of pegmatites from south-eastern Manitoba as the greatest thus far measured. A like age is found by Hurley[5], using helium age determinations, for an east–west orogenic belt of infolded rocks in Ontario: the area of granites and pegmatites from south-eastern Manitoba lies on this east–west belt if extended westward. Holmes[3] calculates an age of 1,985 × 10^6 years from lead/uranium data, from uraninite, and Ahrens[4] finds 2,100 × 10^6 years based on the strontium/rubidium measurements on four specimens of lepidolite. The agreement is very good; but neither measurement can be regarded as wholly satisfactory. For the calculation of the lead age, some corrections have had to be applied[3], whereas the strontium ages, although undoubtedly of the right magnitude, are not precision measurements.

New measurements have been made, using the strontium method applied to a specimen of lepidolite. Recently developed spectrochemical methods (in preparation for publication) were used for the analysis of rubidium and of strontium.

Apart from the random error in any method of analysis, a spectrochemical procedure frequently introduces a systematic error because of the use of synthetic standards. In the present determinations, however, systematic error is believed to be absent, and there is only a relatively small random error (see below). Five determinations of rubidium and nine of strontium were made (see table).

Lepidolite from the Winnipeg River, South-eastern Manitoba

	Rubidium (%)		Strontium (%)
	2·56		0·020
	2·56		0·017
	2·60		0·023
	2·78		0·020
	2·64		0·014*
			0·019
Mean	2·64 (± 0·06)		0·025
			0·016
			0·030*
		Mean	0·0205 (±0·0012)

* These two deviations are unusually large for this method; whether or not they are included in the calculation of the mean matters little, however.

Strontium concentrated from the specimen of lepidolite was shown by mass spectrographic analysis as more than 99 per cent radiogenic. This analysis was made by W. T. Leland in A. O. Nier's laboratory at the University of Minnesota.

For the calculation of the age of the specimen, the mean (5·9 × 10^{10} years) of the half-lives of rubidium-87 given by Eklund[6] (5·8 × 10^{10} years) and Haxel, Houtermans and Kemmerich[7] (6·0 × 10^{10} years) was employed. The age works out at 2,400(2,380) × 10^6 years.

This measurement replaces the earlier more approximate strontium measurements. Agreement is reasonably good with these earlier strontium measurements and with the lead measurements, and there seems no doubt whatever about the great age of the pegmatites.

The difference of 400 × 10^6 years between the new strontium age and the lead age does, however, seem large enough to be significant. At this stage the reason for the discrepancy is not apparent. Further lead age-determinations which are thoroughly reliable (no correction necessary) on relatively fresh uraninite are highly desirable; precise checking of the half-life of rubidium-87 is also desirable.

This investigation was supported by the Office of Naval Research, Washington.

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Use of Plastics in the Fresnel Rhomb

In this note the suitability of the new optical plastics for use in the Fresnel rhomb is discussed. Because the polarizing angle for a dielectric-to-air surface varies very little with change of frequency, and its polarizing properties are affected less by surface deterioration and the presence of films than is the case with metallic surfaces, polarization by internal reflexion remains the most satisfactory means of producing circularly polarized white light. The problem exists as to what is the most suitable non-metallic medium for this purpose. It is hoped that the following considerations will show that choice is not restricted to the classical glasses adopted since Fresnel's time.

The essential requirement of the polarizing medium is that its refractive properties will permit the realization of the necessary phase difference, $\pi/2$, between the components of the incident vibration, preferably at a single reflexion. This requires the satisfaction of the relationship[1]

$$\Delta = \frac{\pi}{2} = 2 \tan^{-1} \frac{\cos i\,(\sin^2 i - 1/n^2)^{1/2}}{\sin^2 i},$$

where i is the angle of incidence and n is the refractive index of the medium for light passing to it from air. It follows that Δ cannot exceed $2 \tan^{-1} (n^2 - 1)/2n$, and a phase difference $\pi/2$ can be produced by a single reflexion only when n is not less than 2·414. Diamond, $n_D = 2{\cdot}417$, is ideally suited for this purpose. Because of the inherent disadvantages of such highly refractive materials for use in prisms, however, it has been necessary to employ two internal reflexions, preferably at the same angle of incidence to prevent deviation of the light beam, as is done in the Fresnel rhomb.

The medium most suited for use in the polarizing rhomb, in addition to being of low dispersion, must possess a refractive index such that $d\Delta/di = 0$, to minimize errors in phase difference due to any incorrect adjustment of the angle of incidence. Since the dispersive powers of the common glasses vary approximately proportionally to their refractive indices, and as $\Delta_{\max.} = \pi/4$ when $n = 1{\cdot}497$, $n_D = 1{\cdot}497$ and $\varphi = 51° 47'$ are the most suitable refractive index and angle for the rhomb respectively. In practice, however, for stability reasons it is customary to use a 54°-prism constructed from the least refractive of the stable borosilicate crown glasses for which $n_D = 1{\cdot}51$, although $n_D = 1{\cdot}49$ is within the range of refractive index of the seldom used and less stable fluor crowns.

The low dispersive optical plastics, because they possess a refractive index in general less than that of glass, usually in the range 1·49–1·50, are ideally suited for rhomb construction. A number of satisfactory rhombs have been made in the various media of this class now available.

For precision work, these prisms suffer from the defects at present common to the optical plastics, due to the instability of their surfaces and their ability to absorb water vapour; in addition, a certain amount of light scattering is apparent. It is hoped that in the future these difficulties will be overcome. For the present the plastic rhombs possess many advantages for demonstration and student use, one of which is that they can be readily constructed in laboratories where glass-working equipment is not available.

Acknowledgment is made to the Australian Commonwealth Research Grant Committee for a grant made available for this work.

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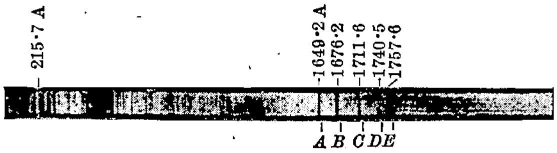
Absorption Spectrum of Indium Vapour in the Schumann Region

The ground-state of the indium atom is $5s^2\,5p\;{}^2P^0_{1/2}$, and the term system responsible for the ordinary series spectrum—that is, the system built on the $5s^2\;{}^1S_0$ ground-state of the ion—was summarized and extended by Paschen[1]. Also included in his list are the following three terms: $5s5p^2\;{}^4P$, $5s5p^2\;{}^2D$ and $5s5p6s\;{}^4P$. Of these, the first-named was originally identified by Sawyer and Lang[2] and by Lansing[3] independently, and seems well established; the other two terms are much more tentative. The sp^2-configuration should give other, hitherto unidentified terms, ${}^2S$ and ${}^2P$, remembering that the use of Russell-Saunders symbols is merely conventional, as we are dealing with a case which probably departs markedly from LS-coupling. Rough estimates indicate that these terms, and those of other configurations in which two electrons are excited, will lie above the normal ionization potential.

It is well known from Beutler's studies of a number of elements[4] that a profitable method of seeking certain of such highly excited terms lies in observation of the absorption spectrum of the vapour of an element in the spectral region on the short wavelength side of the ionization limit. While the method only reveals combinations which occur in reasonable strength with the ground-state, it has the advantage of showing up transitions not readily observed in emission owing to auto-ionization.

The absorption spectrum of indium vapour in the Schumann region has been obtained in this laboratory, by the use of a one-metre normal-incidence grating, a carbon-tube furnace as absorption vessel, and a heavy-current hydrogen tube as source.



The accompanying reproduction shows a typical spectrogram, obtained at a furnace temperature of 1,250° C. The hydrogen tube yields a continuum down to 1650 A., and extending below this, the closely packed many-line spectrum of H_2. Five intense absorption lines can be seen in the region 1600–1800 A. At a furnace temperature of 950° C., the lines labelled *A*, *B*, *C*, *E* are intense, line *D* just visible, becoming plain at 1,100°. The lines *A* and *C* are fairly sharp, *B* and *D* rather diffuse and *E* very diffuse. At 1,400° a further diffuse absorption line, *F*, occurs upon the many-line spectrum at 1318 A., and the series lines $5^2P^0_{1/2} \rightarrow m^2D_{1/2\;3/2}$ up to $m = 23$, as well as the series limit continua, are then seen plainly in absorption.

While the results of initial measurements of the six far ultra-violet lines are not of high accuracy, the wave-number intervals, combined with considerations of the character of the lines and probable coupling conditions, lead to the tentative conclusion that lines *A* to *D* represent the *PP′* multiplet $5^2P^0 \rightarrow 5s5p^2\;{}^2P$, and *E* and *F* are respectively $5^2P^0_{3/2} \rightarrow 5s5p^2\;{}^2S_{1/2}$ and $5^2P^0_{3/2} \rightarrow 5s5p6p\;{}^2S_{1/2}$. Four new levels are thus identified:

$5s5p^2\;{}^2P_{3/2}$ — 13964 cm.$^{-1}$ $5s5p6p\;{}^2S_{1/2}$ — 31421 cm.$^{-1}$.
${}^2P_{1/2}$ — 12989
${}^2S_{1/2}$ — 12439

The observation of the diffuse series up to $m = 23$, noted above, represents an addition of nine members to those recorded by Paschen. However, it is doubtful whether accurate measurement of these is possible on the low-dispersion pictures so far obtained; an attempt to use a higher-dispersion quartz instrument may be made later.

A full account of the work described and details of further experiments in hand will be published elsewhere.

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The Scintillation of Stars

In a recent communication in *Nature*[1], Dr. A. H. R. Goldie has suggested that the scintillation of stars may be associated with waves at an interface between two currents of air which have a difference of temperature of the order of 5–7° F. "Such waves," he writes, "should not uncommonly have an amplitude of the order of up to 500–1,000 ft. at the interface, wave-length up to 10 miles or more, speed anything up to 40 ft. per sec., but probably usually lower."

It does not seem likely that these waves are the cause of scintillation, for the following reasons. If these waves travel at usually not more than 40 ft. per sec. and have a wave-length of 10 miles, then three wave crests will pass a given point in one hour. Now stars twinkle at different periodicities, and in the case of Sirius each cycle has a duration of roughly 1 sec. and other stars are not very different. If this cycle is caused by air waves of ten miles wave-length, their rate of travel would have to be about one thousand times faster than that suggested by Dr. Goldie. Alternatively, if the speed he has suggested is correct, then the wave-length would have to be correspondingly shorter, say about 50 ft.

Apart, however, from the fact that the waves described by Dr. Goldie do not appear to have either the correct speed or the correct wave-length to fit in with the cycle of star scintillation, I have shown in previous letters that even if there were waves which did fit in with the cycle, they still would not produce the phenomena associated with scintillation. It would be expected that the waves would produce (*a*) clearly marked side shifts at right-angles to the long axis of the waves, and (*b*) spectra, owing to dispersion of light at the interface between the two air currents. But neither of these phenomena is to be found. What we do see when we look at stars are changes in light intensity and changes in colour, from pink through white to a pale blue-green. But neither the one nor the other can be adequately explained on the basis of air waves.

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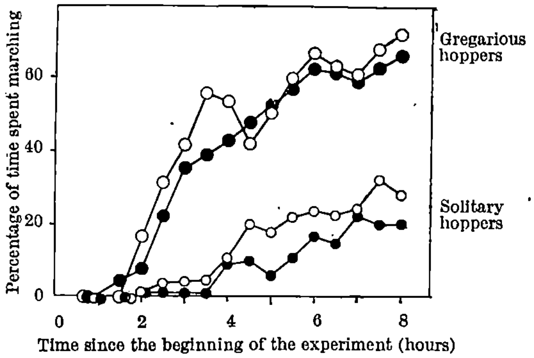
Marching in Locust Hoppers of the Solitary Phase

Locust species exist in two phases differing in colour, anatomy and behaviour with intermediate forms between the two extremes[1,2]. The nymphs (hoppers) of the gregarious phase are black and orange in colour; they congregate and wander or march in bands. Hoppers of the solitary phase are green or brown; they live in isolation and do not march. In the laboratory, the two phases can be produced by crowding or isolating the individuals during rearing.

Some field records mention green hoppers in gregarious bands; but it is generally assumed that marching is characteristic of the gregarious phase only. Kennedy[3] first suggested, and Volkonsky[4] put forward a definite hypothesis, that hoppers of the solitary phase also possess the necessary mechanisms for marching, the difference between the two phases being only quantitative.

It is now possible to obtain marching in cages, and I have compared the marching behaviour of fourth instar hoppers of the two phases of *Locusta migratoria migratorioides* (R. & F.). Gregarious hoppers had gregarious parents, and solitary hoppers, solitary parents. The results confirm that marching is a behaviour pattern not of the gregarious phase only, but of the locust species as a whole. There is, however, a clear quantitative difference between the two phases, solitary hoppers marching for less of the time, and at lower speeds, than hoppers of the gregarious phase.



In the first group of experiments, eighteen hoppers of the same phase were put together in a cage, and the percentage of time spent marching recorded for marked individuals. The accompanying graph gives the results for two experiments on each phase, and shows that solitary hoppers march, but for less of the time than gregarious hoppers. During the last three hours of these experiments, the speeds of hoppers while marching were recorded. The averages of twenty results for each phase are shown in Table 1. The difference is significant; hoppers of the solitary phase march more slowly than those of the gregarious phase.

Table 1. Marching Speed (cm. per sec.)

Solitary hoppers.	Mean	1·65	cm. per sec.	1·5	S.D.	1·45
Gregarious ,,	,,	3·67	,, ,, ,,	1·8	S.D.	1·89

Difference between the means, 8·78 times the standard error of the difference and thus significant.

In the second group of experiments, single marked solitary and gregarious hoppers were dropped into a cage of marching gregarious hoppers, and their activities noted for a specified length of time. The average percentage of time spent in marching for each hopper was calculated, and the results analysed statistically (Table 2). These results show that solitary hoppers are capable of joining a marching stream, but there is again a quantitative difference between the two phases.

Table 2. Percentage of Time Spent Marching

Solitary hoppers.	Mean	26·1%	3·8%	S.D.	16·1	No. of cases	18
Gregarious ,,	,,	49·2%	2·6%	S.D.	15·0	,, ,,	33

Difference between the means, 5·05 times the standard error of the difference and thus significant.

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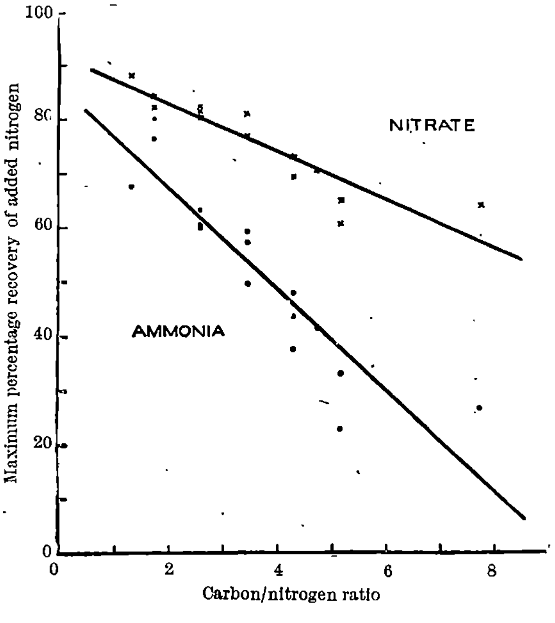
Effect of Carbon/Nitrogen Ratio upon the Formation of Nitrate and Ammonia from Amino-acids in Soil

In the course of an investigation into the decomposition of nitrogenous materials in the soil, we have in one experiment found a highly significant correlation between carbon/nitrogen ratio and the formation of both ammonia and nitrate from a series of amino-acids added to the soil.

The importance of the carbon/nitrogen ratio in relation to biological processes in the soil has long been recognized[1,2]. Working with amino-acids, Batham[3] reported that nitrification appeared to be independent of carbon/nitrogen ratio, but later[4] observed a fairly close relationship for nitrogenous compounds more complex than the monoamino-monocarboxylic acids. More recently, Quastel[5] reported that for glycine, alanine and sodium glutamate, recovery of added nitrogen as nitrate was inversely related to carbon/nitrogen ratio.

In the present experiment the following sixteen amino-acids were used: L-arginine hydrochloride, L-histidine hydrochloride, L-glutamic acid, L-tyrosine, L-lysine hydrochloride, L-proline, DL-alanine, DL-tryptophane, DL-serine, DL-valine, DL-leucine, DL-*nor*-leucine, DL-threonine, DL-aspartic acid, α-amino-*iso*-butyric acid and glycine. Each amino-acid was mixed with market-garden soil in quantities calculated to supply 300 p.p.m. nitrogen, except for histidine, lysine and arginine, which were at concentrations of 275, 273 and 248 p.p.m. respectively. The soil was kept in an incubator at 23·5° C. and each batch sampled at least nine times over a period of twenty-five days, analyses being made for ammonia and nitrate. From the results, the maximum values for percentage conversion to ammonia and nitrate were obtained for each amino-acid and plotted against the carbon/nitrogen ratio, as in the accompanying graph.

Taking the carbon/nitrogen ratio as the independent variate (y), the equation to the regression of ammonia (x) on the carbon/nitrogen ratio is $X = 86\cdot0 - 9\cdot36y$ and the correlation coefficient r is $-0\cdot91$. Nitrate values (x_2) for only fourteen amino-acids were available, as the quantities of threonine and proline proved insufficient to allow completion of the experiment. The regression equation is $X_2 = 91\cdot9 - 4\cdot45y$ and again r is $-0\cdot91$, showing a highly significant correlation.



It is evident from these results that the effect of carbon/nitrogen ratio is more marked on accumulation of ammonia than of nitrate. If the occurrence of ammonia and afterwards of nitrate in the soil during decomposition of organic nitrogenous compounds be taken to signify that nitrogen is present in the added material in excess of the growth requirements of the organisms concerned, then the influence of the carbon/nitrogen ratio would, in fact, be expected to be more marked in the early stages of the transformation, when the supply of utilizable carbon compounds is greater, rather than at the end when nitrate values approach their maxima. Further experiments with amino-acids are in hand.

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Photoperiodic Induction in Jute and a Great Acceleration of Vegetative Growth in *C. capsularis*

Both the species of jute, *Corchorus capsularis* L. (*D* 154) and *C. olitorius* L. (*C.G.*), have been found to behave as short-day plants[1,2]. In a further investigation on the photoperiodic effect in jute, the effect of a number of light periods continuous until flowering and for shorter periods has been studied. The mean flowering time of twelve plants per treatment grown in pots and the mean heights at flowering were noted. There were two sowings—on April 17, 1948, and on June 2, 1948. Plants of April sowing were subjected to 14 days, 21 days and continuous 8 hours, and to 14 days, 21 days and continuous 10 hours treatments, and those of June sowing to 7 days, 14 days and continuous 10 hours and to 7 days, 14 days, 30 days, 60 days and continuous 14 hours treatments.

In *C. olitorius* the shortest flowering time is seen in 10 hours continuous treatments of April sowing, flowering in 21 days and showing an earliness of 105 days from control which flowered in 126 days, and there was no significant difference between the continuous 14 days and 21 days treatments for 8 hours periods, the mean flowering time being about 25 days. The heights at flowering in all the short-day treatments were also very low, varying between 6 cm. and 11 cm., except in 10 hours 14 days treatment the height of which at flowering was 28 cm. with a flowering time of 32 days. In the long light period treatments of June sowing, the greatest lateness of flowering of 98 days flowering in 185 days against 87 days of control and a greater height of 76 cm. (275 cm. against 199 cm. of control) are seen in 14 hours continuous treatment, but in 7 days, 14 days and 30 days treatments flowering takes place practically at the same time as control; but 60 days treatment causes a significant lateness, flowering in 91 days.

In *C. capsularis* the shortest flowering time of 33 days is found in 10 hours continuous treatment,

owing an earliness of 98 days from control which
wers in 131 days in the sowing of April, and a
wering time of 37 days is found in 10 hours con-
uous and 10 hours 14 days treatments of June sow-
, showing an earliness of 56 days from control
ch flowers in 93 days. In the long light period
tments there is a lateness of flowering of 58
in 14 hours continuous treatment which flow-
in 151 days. Even 7 days treatment at 14
s showed a significant lateness, and lateness
ased with the duration of treatment (7 days,
ys, 30 days and 60 days); but the difference in
ring time between 7 days and 14 days, 14 days
0 days, and 30 days and 60 days treatments are
atistically significant, and the flowering time of
ys treatment at 14 hours was 97 days.

capsularis seems to be slightly more sensitive
rly period treatments in the long light periods
C. olitorius; but the latter is much more
tive than the former to the early period treat-
s in short light periods. The photo-inductive
[illegible] case of both the species consists of 10
[illegible] d and 14 hours darkness period, and
[illegible] cycles are sufficient to induce
[illegible] g, 21 cycles being necessary for
[illegible] s. In *C. capsularis* after exposure to
[illegible] t was found that although a few flowers
ced early, they were shed, and the plants
her prolonged vegetative growth came to
uction of normal flowers leading to the pro-
of fruits about the same time as the plants
d to the normal daily light period. It may be
hat in this case the amount of supposed flower-
rmone produced had just reached the critical
tration, and the internal conditions of the
so treated is similar to the plants of *C. olitorius*
on March 31[3]; the works of Harder[4] on
hoe blossfeldiana, and Meyer[5] on *Sedum*, to
the effect of reduced flowering hormone may
ioned in this connexion.

capsularis of March sowing in the 8 hours
ent for 14 days and 21 days and 10 hours
ent for 14 days, flowering took place only a
ys earlier (by 8–13 days) than the control;
e differences are statistically significant. But
plants showed a remarkable acceleration of
tive growth in that they grew to much greater
s (236 cm., 253 cm., 253 cm., respectively,
t 182 cm. of the control), showing increased
h by 54–71 cm. That they showed an earliness
wering points to the early production of flowering
one during the short light period treatment, and
the flowering took place only a few days before
ormal point, indicate that the auxin of vegeta-
growth was predominant, and the comparatively
ll concentration of the flowering hormone formed,
w the critical concentration, could not express
lf earlier; on the approach of the short light
iod of Nature, the balance between the flowering
mone and auxin shifted to the flowering side.
toperiodic experiments with various plants point
he general conclusion that auxin exerts an in-
nce which opposes flowering, and early pro-
tion of flowers is associated with the inhibition of
tative growth[6]; and Cholodny's thesis that the
ering stimulus is exerted by a group of sub-
ces, one of which is auxin, is not supported by
results of various experiments, although a
king exception of generally somewhat antagon-
effect of auxin to flowering is furnished by
apple[7].

The acceleration of growth reported here is remarkable, and it may be that when the plants are exposed to non-photo-inductive cycles after the production of some concentration of flowering hormone less than the critical concentration by exposure to a few photo-inductive cycles, the flowering hormone is partly converted into, or more probably stimulates the production of larger quantities of, normal auxin of plant growth; and under such conditions the two factors do not seem to be working in opposite directions. Production of sufficient quantities of flowering hormone by exposure to large numbers of photo-inductive cycles more than the critical, however, produces great earliness of flowering accompanied by the usual inhibition of vegetative growth.

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Habits of the Marine Tardigrade, *Echiniscoides sigismundi*

IT would appear that, although tardigrades are often common in many situations in fresh waters, they are comparatively rare, or at least have escaped frequent observation, in the sea. This is particularly true of British waters, for which only two records can be traced. Both of them refer to the same species, *Echiniscoides sigismundi* (Schultze). The first record is that of Murray[1] from the west coast of Ireland, and the second is that of Cole[2] in 1934 from North Wales. In both instances the creature was found among seaweeds. Yet it is quite clear both from Marcus[3] and Cuénot[4] that *E. sigismundi* is widely distributed in the Mediterranean, North Sea and Caribbean Sea, and even off the coasts of China. It is difficult to account for its apparent absence from most British coasts except on the supposition that it has not so far attracted attention.

In January of this year, three specimens were found in the mantle cavity of a common mussel brought from Whitstable by G. E. Newell, and on several subsequent occasions they have been found in similar situations. Yet, despite a careful search of seaweeds and of material sieved in a plankton net from the same area from which the mussels were obtained, no tardigrades have been found free-living. This leads to the view that some relationship other than a casual one exists between the tardigrades and the mussels. On the other hand, records from abroad give the creature as living with seaweeds, particularly the green alga *Enteromorpha*, so that, if any definite association with mussels does occur, then it is a facultative one. In support of this view it may be remarked that Marcus mentions several other marine tardigrades (not British ones) which seem to be associated with particular animals. One, for example, *Halechiniscus guiteli* Richters, is found in and on oyster shells. Another, *Actinarctus doryphorus* E. Schulz, Marcus regards as a facultative parasite on the echinoid, *Echinocyamus pusillus*, and a third, *Tetrakentron synaptæ* Cuénot, is a parasite on the tentacles of the holothurian *Leptosynapta galliennei*.

Thus it is not unusual for a tardigrade to be associated with another invertebrate animal, and it may be suggested that *E. sigismundi* is a facultative commensal of the common mussel.

It may be useful here to point out that *E. sigismundi*, the only marine tardigrade so far to be reported as a member of the British intertidal fauna, is easily recognizable by being about 0·2 mm. long and having five to eleven claws (usually eight) on each of its four pairs of legs.

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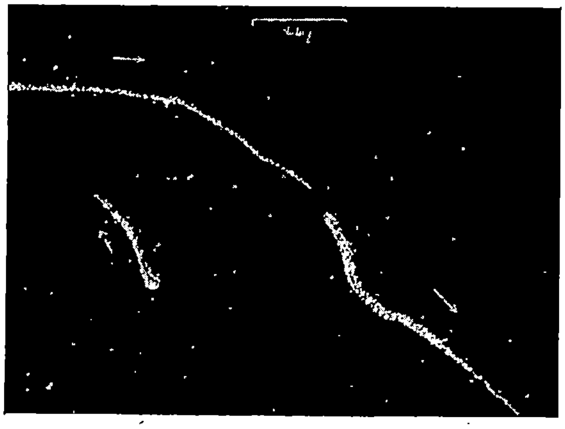
Odour Trails of *Acanthomyops fuliginosus*

SINCE Bethe's[1] original work on the polarization of the scent trails of the ant *Acanthomyops niger*, numerous theories have been put forward to explain the phenomenon. The majority, particularly those of Wasmann[2], Forel[3] and Brun[4], resulted from work on *Acanthomyops fuliginosus*, a species which in Nature, unlike *A. niger*, forms long columns of workers going to and fro between nest and food. Polarization in these trails was claimed to arise from the individual pieces of the trail. According to Wasmann[2], these were the footprints of the workers, which would have a direction implicit in them, like a human footprint.

In a comparative study of the orientation capabilities of both *A. niger* and *A. fuliginosus*, the existence and shape of the scent trail has been demonstrated in the latter. The workers used were carrying larvæ into the nest from a pile placed in the centre of a circular glass arena, 1 ft. across. Very quickly a worker will learn the way to and from the larvæ and soon settles down to follow roughly the same course in the two directions. If the glass over which it is running is dusted with lycopodium powder, this adheres to the scent trail and throws it into relief.



Part of an odour trail of *Acanthomyops fuliginosus* (dusted with lycopodium powder). The arrows show the direction of running

The result can be photographed, showing a
up into dashes of about 4 mm. long, shap
they have the appearance of a drop of fluid
and drawn out in the direction of running,
seen on the accompanying photograph. It
be seen without 'development' if the glass
an angle to the light. The form of the tra
with the individual and sometimes the da
be up to 8 cm. long. It is of interest th
considered that scent trail-laying only to
when the workers were carrying food.

The ability to lay such a trail is under th
of the ant. In the first journeys over the
glass, pieces of trail are laid while returnin
nest and the remainder of the distance co
random movement. As familiarity incre
trails are completed and new whole ones la
mainly while carrying the larvæ. The res
about ten journeys is a tangle of trails over
favoured route. This confusion would cle
clude any polarization based on the shap
dashes, a criticism of Bethe's theory[1] wh
put forward. Certainly a worker
the larvæ may, in the preliminary
the beginning of the trail, strik
and turn nestwards instead of tow
Further, the trail is not followed in all
detail; but the ant runs with one antenna
along the track. There is no sign of the
being used as callipers to sense the 'odour
the trail, as Forel[3] postulated. This agre
Chauvin's[5] findings of non-polarization of t
in this ant and with his explanation that
results[1] of confusion, when sections of the t
reversed, were due to the interruption of th
rather than its inversion, since after the rever
ends of the sections no longer coincided wi
ends of the other parts of the trail. However
gregor[6] has supposed the spots forming the
trail in *Myrmica ruginodis* to be orientat
they appear to be interpreted by the indiv
this way. The chemical constitution of the
under investigation. It seems likely that it
anal secretion.

Despite Bethe's results[1], no similar trail ha
demonstrated in *A. niger*. Indeed, from its beh
under normal and experimental conditions,
clear that this ant depends upon visual me
orientation. However, on one occasion when a w
was apparently disorientated, it showed the
excitement behaviour by backing slowly in a
circle, jerking up and down with its abd
vibrating, and at the same time a small amou
material was deposited. This, coupled with
stages of the journey during which the trail is
by *A. fuliginosus*, suggests the possibility that
deposition of the scent trail may depend on excit
of the ant by the presence of food or larvæ
from a by-product of heightened excitation *A. n*
it has become the main method of orientatio
A. fuliginosus.

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[2] Wasmann, E., *Zoologica*, **11**, 26 (1899).
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[5] Chauvin, R., L'Année Psychologique. Mémoires Originaux l'expérience de Bethe" (1944–45).
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eding Mechanisms in Anuran Tadpoles

AN confirm that the method of mucous cord g referred to by Dodd[1] plays a part in the al lives of tadpoles of *Rana temporaria, Bufo* and *Bombina variegata* living under natural or atural conditions. It is, however, remarkable among the many tadpoles which have been ned, definite mucous cords have been seen in few. The animals appear to use this method n the presence of fine particles; but seem to nother means of dealing with the coarse material so often forms their food. Whole *Daphnia*, arvæ or spiders are not uncommon constituents food, and much exceed the diameter of the

dy of the pharynx of several species of Anura own that the velum is in two parts, ventral rsal, of very different structure. The ventral is continuous with the floor of the pharynx, ppears to vary in elevation so that the water passing over it is sometimes directed wall of the pharynx (in the centre, phageal opening); but in other ral velum the water strikes the just anterior to the dorsal velum. pocket, with the opening facing forward, down into shape by a stream of water. positions of the edges of the dorsal and a are often such that the water must blow velum open. It is in the shielded space on nstream side of the dorsal velum that the cords form; but the coarse material seems to more ventrally, when, indeed, it is not in the geal funnel itself.

striking the posterior wall of the pharynx, esophageal opening, must turn ventrally and wards through almost 180° before escaping the gill filters. It is suggested that, during turn, large objects leave the stream due gal action. The efficiency of such separa ases with the size of the particles, so that iculty in the relative size of the cords and does not arise.

microphagous species, *Chaperina fusca*, the velum is widely interrupted in the centre, ere in *Rana* and *Bufo* it is most strongly ed opposite the œsophagus; but the dorsal which in *Rana* and *Bufo* is interrupted in the is continuous in *C. fusca*, with merely a tion in size near the central line.

gill filters do not usually have much food hem, and may serve merely to retain food rown out of the stream on the first circuit. always been difficult to explain how the food filters gets to the œsophagus against the prevailing current of water. If, however, the filters take sidiary role, this small amount of food may be n back into the pharynx by a back-wash of from the atrium, during inspiration. The ate passage of water containing, on both sides filter, suspended matter which is often gelatin ould seem to be a dangerous proceeding; but trium contains water which has already been d, and will not clog the filter on the under side,

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[1] J. M., *Nature*, 165, 283 (1950).

Exoerythrocytic Schizogony in Bat Malaria

MALARIA parasites of the epauletted fruit bats of tropical Africa have been described by Rodhain from the Belgian Congo, by Rousselot from French West Africa, and by myself from Kenya. Dr. R. B. Heisch, of the Division of Insect-borne Diseases, Kenya, noted the presence of a similar parasite in *Epomophorus wahlbergi* and was kind enough to have a number of these bats collected from near Nairobi for me when I was on a visit to the East African territories.

Seventeen bats were examined, and gametocytes were found in the blood of four. Tissues from the infected specimens were prepared for sectioning; in the liver of the most heavily infected were found the exoerythrocytic schizonts of the parasite. The smallest schizont was a spherical object about 45 μ in diameter with a deeply convoluted surface, and extremely dense cytoplasm studded with nuclei. A larger form measured 70 μ × 55 μ. These immature parasites lay between the parenchyma cells, and it was impossible to determine where they had originated. After a period of further growth, the substance of the parasite appeared to divide into a large number of well-defined cytomeres enclosed within a thick wavy border of unknown origin. These cytomeres were more numerous at the periphery, where presumably final division occurs. The last stage of merocyst formation was not found, though post-mature bodies were common in the shape of foci of phagocytic cells, including giant cells surrounding and invading many free merozoites. Such foci were easily visible as tiny white opaque spots on the surface of the liver.

Sections of heart and lung revealed no schizonts. Further examination of the material will be made at a later date.

Exoerythrocytic schizogony in insectivorous bat malaria was described by Mer and Goldblum[1], and has a totally different character from the appearances briefly recorded here. The latter are sufficiently striking to enable me to assign this parasite of African fruit bats to the genus *Hepatocystis*, the main features resembling the developmental stages of *H. kochi*.

I have pleasure in acknowledging the many facilities for this study provided by the Division of Insect-borne Diseases, Medical Research Laboratory, Kenya.

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[1] Mer, C. G., and Goldblum, N., *Nature*, 159, 444 (1947).

Failure of Antibiotics in Experimental Rabies

As chloromycetin has shown promising results in various virus infections in man, it was decided to investigate its activity against experimentally induced rabies. Two rabbits were inoculated intracerebrally with the strain of fixed virus previously described by Kirk in *Nature*[1]. The rabbits received respectively 100 and 200 mgm. of chloromycetin per kilo daily, given in three equally divided doses by mouth. As controls three rabbits were used; two received 20,000 units penicillin in procaine oil per kilo daily, and the third 40 mgm. of streptomycin per kilo daily in two equally divided doses by intra-muscular injection. Therapy was started in all cases twenty-four hours before inoculation. All five rabbits died on the fifth day and no change in the incubation period or manner of death could be detected.

It would appear that the antibiotics used have no effects on the progress of experimentally induced rabies.

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Stack Medical Research Laboratories,
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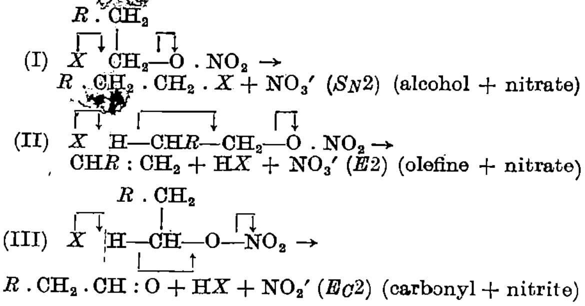
[1] *Nature*, **143**, 77 (1939).

Hydrolysis of Organic Nitrates

Early work[1] gives a very confused picture of the reactions which occur in either alkaline or acid hydrolysis of organic esters of nitric acid. The only clearly established point is the occurrence of reactions other than simple fission to alcohol and nitric acid, and the general view was that such side-reactions, including the formation of nitrite, arise from subsequent oxidation of the alcohol by the nitric acid. A more recent study, by Lucas and Hammett[2], of the solvolysis of *tert.*-butyl nitrate revealed the concomitant formation of *iso*butene, while with benzyl nitrate, benzaldehyde and nitrite are also formed.

Analogy with the picture of nucleophilic substitution (S_N) and elimination (E) reactions of alkyl halides, etc., which has resulted from the extensive investigations of Hughes, Ingold and their collaborators[3], and in which a duality of mechanism (uni- and bi-molecular) has been established, suggests that hydrolytic fission of organic nitrates might involve the following three reactions ; for simplicity only the bimolecular mechanisms are depicted, although it is evident that, under suitable structural and environmental conditions, the corresponding unimolecular mechanisms may function :



$$\text{(I)}\quad X \;\; \overset{R\,.\,\mathrm{CH_2}}{\mathrm{CH_2}}\text{—O}\,.\,\mathrm{NO_2} \rightarrow R\,.\,\mathrm{CH_2}\,.\,\mathrm{CH_2}\,.\,X + \mathrm{NO_3}' \;(S_N2)\;\text{(alcohol + nitrate)}$$

$$\text{(II)}\quad X \;\; \text{H—CH}R\text{—CH}_2\text{—O}\,.\,\mathrm{NO_2} \rightarrow \mathrm{CH}R : \mathrm{CH_2} + \mathrm{H}X + \mathrm{NO_3}' \;(E2)\;\text{(olefine + nitrate)}$$

$$\text{(III)}\quad X \;\; \text{H—}\overset{R\,.\,\mathrm{CH_2}}{\mathrm{CH}}\text{—O—NO}_2 \rightarrow R\,.\,\mathrm{CH_2}\,.\,\mathrm{CH} : \mathrm{O} + \mathrm{H}X + \mathrm{NO_2}' \;(E_C2)\;\text{(carbonyl + nitrite)}$$

These involve, respectively, attack by the nucleophilic reagent $X (= \mathrm{OH}', \mathrm{H_2O}, R\mathrm{OH}$, etc.) at the α-carbon, β-hydrogen or α-hydrogen. Theoretically, all these reactions might occur in either alkaline, neutral or acid media.

We are engaged on a detailed kinetic study of these reactions for a large number of organic mono-nitrates in dilute alkaline, neutral and acid aqueous alcoholic solutions, in which the separate reactions I–III have been followed by parallel determinations of OH′ (or $\mathrm{H_3\overset{+}{O}}$), $\mathrm{NO_3}'$, $\mathrm{NO_2}'$, olefine, and carbonyl derivative. One inherent difficulty in determinations by acid–alkali titration is the very small velocity of hydrolysis of simple alkyl nitrates in dilute solution, with the result that, in alkaline media, extensive alkali attack on glass vessels occurs during the course of the experiments, so that the values of [OH′] obtained bear no relation to the true course of the nitrate hydrolysis. This is a factor which would seem to have been overlooked in the early investigations. This difficulty has been overcome by designing suitable polythene vessels, for which it has been shown that any alkali attack on the vessel is negligibly small during the (prolonged) period over which the hydrolytic reactions have been studied. Under these conditions there is satisfactory agreement between the loss of [OH′] and the amount of nitrate formed (when only reactions I and II occur), or of nitrate plus nitrite (when all three reactions are superimposed).

Although our data are as yet incomplete, sufficient have been obtained to prove a corresponding agreement between the amount of $\mathrm{NO_2}'$ and C=O derivative formed (reaction III) throughout the course of the reaction. As expected, under the experimental conditions, no oxidation of alcohol is effected by the nitrate ion.

It would appear, therefore, that the formation of olefines, carbonyl derivatives and nitrite does not arise from secondary reactions but from the concomitant occurrence of three main reactions, in two of which (I and II) fission occurs at the C—O linking, and in the third (III) at the O—N linking in the nitrate molecule.

A fuller account of this work will be published elsewhere when the investigation is complete.

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March 18.

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[1] Cf., *inter alia*, Farmer, *J. Chem. Soc.*, **117**, 806 (1920) ; and references cited there.

[2] *J. Amer. Chem. Soc.*, **64**, 1928 (1942).

[3] For summarizing papers, cf. Hughes, *Trans. Farad. Soc.*, **37**, 603 (1941) ; Hughes and Ingold, *ibid.*, 657.

Role of Oxygen in the Photolysis of Iodides

The decomposition by ultra-violet light of organic compounds containing iodine in solution has been the subject of many investigations, and references to this phenomenon are scattered throughout the photochemical literature. Summaries of the results and conclusions reached by the various investigators have been fairly well dealt with in recent books on the subject[1]. In the majority of cases, the quantum yields of the photochemical process have been determined by the amount of iodine formed in relation to the light absorbed. For the alkyl iodides, at least, these yields show no intelligible variation among themselves, and often the yield for a particular iodide varies from one investigator to another. There always has been a doubt as to whether or not dissolved oxygen was involved in the photolysis[2], in spite of the fact that many investigators have taken the trouble to distil their materials *in vacuo*, or to bubble inert gases through the solution before the photolysis. More convincing work along these lines has been undertaken in recent years by Olaerts and Jungers[3] ; but it remains to be seen if they have really succeeded in removing the last trace of oxygen from their solutions.

During an investigation of the photodecomposition of iodoacetic acid in hexane, we noticed that the quantum yield for iodine formed (Φ_{I_2}) continued to decrease as more and more precautions were taken to remove the last traces of dissolved oxygen. When no trouble was taken to remove atmospheric oxygen,

= 0·49 ; after bubbling pure, oxygen-free nitro- n through the solution, $\Phi_{I_2} = 0{\cdot}42$; on distilling d freezing out *in vacuo*, $\Phi_{I_2} = 0{\cdot}38$. A more tensive distillation *in vacuo* was then undertaken : e solution was transferred by evaporation and con- nsation from one vessel to another at least six mes. It was then found that although the amount f light absorbed was the same as before for the same ncentration, the yield of iodine was practically gligible, $\Phi_{I_2} = 0$. As soon as the solution was pened to the air and oxygen allowed to dissolve, odine began to form at the same rate as before.

We repeated the photolyses in hexane of such iodides as methyl, ethyl, *iso*-amyl, iodobenzene and *p*-iodotoluene in the presence of oxygen, where we und $\Phi_{I_2} \sim 0{\cdot}5$, and after extensive removal of oxygen, $\Phi_{I_2} < 0{\cdot}05$. If we accept the evidence derived from a study of the absorption spectra of such ompounds that rupture of the C—I bond follows n the light absorption, we can only assume that egligible quantum yields are due to recombination of the radicals, R, with the iodine atoms. Does this recombination take place by the formerly accepted mechanism of Franck–Rabinowitsch[4] ?. If the dissolved oxygen reacts with the radical according to accepted ideas[5], the radical and the iodine atom must remain uncombined and surrounded by a sheath of solvent molecules for a relatively long time to able such reactions to take place. One of us (T. I.) inted this out some years ago[6] in a criticism of amford and Norrish's interpretation of ketone otolysis in hexane solution[7].

If the recombination does not take place by a anck–Rabinowitsch mechanism, we must assume at the reaction $R + R = RR$ is a very rare one pared with the reaction $R + \mathrm{I} = R\mathrm{I}$. When the gen concentration is sufficiently high, the reaction $+ O_2 = RO_2$, etc., becomes of importance. Oxygen s a fairly high solubility in hydrocarbons[8], and removal is evidently not easy. These considera- s apply, *mutatis mutandis*, to the photolysis in tion of other kinds of substances involving icals susceptible to oxidation. It does not necess- y follow that gaseous products will be formed, l that evidence of photochemical change will be covered by micro-analysis of evolved gases. Minute unts of oxidized and condensation products ld have to be looked for. Iodine betrays its ence, even in small amounts, by its colour, and nalytical determination is relatively easy. That hy this phenomenon has been so readily detected e case of the iodides. At higher temperatures the bility of oxygen is less, and we find increasing ivity of the radical with the hydrocarbon solvent, e the activation energy must be higher than that ired for the oxidation. More experimental details theoretical treatment of the results of these stigations will be published soon.

S. HACOBIAN
T. IREDALE

ysico-chemical Laboratories,
University of Sydney.
March 13.

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Monoclinic Thorium Silicate

THE name 'huttonite' is proposed for a newly recognized monoclinic mineral of the composition $ThSiO_4$. It has been isolated in minute grains from beach sand of South Westland, New Zealand, by Prof. C. Osborne Hutton, of Stanford University. Its optical properties are : $\alpha = 1{\cdot}898$, $\beta = 1{\cdot}900$, $\gamma = 1{\cdot}922$; dispersion $\rho < \gamma$, moderate ; $2V = 25°$ (measured) ; $Y \parallel b$, Z near c ; colourless to very pale cream. X-ray study by means of powder, rotation and Weissenberg patterns shows that huttonite is isostructural with monazite. Space group $C2_h^5 - P2_1/n$; $a_0 = 6{\cdot}80$ A., $b_0 = 6{\cdot}96$ A., $c_0 = 5{\cdot}54$ A., $\beta = 104° \ 55'$. The measured density is $7{\cdot}1 \pm 0{\cdot}1$. The calculated density, corresponding to a cell content of $4(ThSiO_4)$, is 7·18.

A full description has been submitted to the *American Mineralogist.*

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The Sulphatase of 'Clarase' : Inhibition, Inactivation and Purification

THE optimal conditions and specificity of the enzyme sulphatase of 'clarase' have been described in a previous communication[1]. The method then used of measuring the activity of the enzyme by the gravimetric estimation of sulphate liberated from the substrate has now been abandoned, and a new colorimetric method adopted. In this the amount of phenol set free from the substrate (potassium phenylsulphate) in the course of enzymic hydrolysis is determined, as was done by King and Armstrong[2] for the determination of phosphatase.

Inhibition. The influence of various substances known to be enzyme inhibitors has been examined, as well as that of other compounds not necessarily regarded as such. Of all the substances tested, phenylhydrazine proved to be the most powerful inhibitor of the sulphatase of 'clarase'. Even at a concentration of 10^{-6} M, phenylhydrazine produces a 25 per cent inhibition, and when its concentration is raised to 10^{-5} M, the sulphatase activity ceases completely. Other inhibitors of the sulphatase, in order of decreasing inhibitory action, are named in the accompanying table.

ACTION OF INHIBITORS ON SULPHATASE OF 'CLARASE'

Inhibitor	Molar concentration	% Inhibition
Sodium cyanide	10^{-4}	100
Silver nitrate	10^{-3}	100
Semicarbazide	10^{-3}	77
Lead acetate	10^{-3}	44
Potassium hydrogen phosphate	10^{-2}	25

Other substances, such as barium chloride, ethyl alcohol and strontium nitrate, had no inhibitory effect even at a concentration of 10^{-2} M.

Inactivation. Sulphatase of 'clarase' is very sensitive to low pH. At pH 3 it is irreversibly inactivated after ten minutes, and after five minutes an 80 per cent inactivation of the enzyme occurs.

Purification. A partial purification of the sulphatase of 'clarase' has been achieved by means o fractional precipitation with ammonium sulphate

At 50 per cent saturation with ammonium sulphate, an inactive fraction of 'clarase' is precipitated. In this way, a more concentrated preparation may be obtained. Further attempts are being made towards complete isolation of the enzyme.

L. M. Dzialoszynski

Biochemical Laboratory,
Organic Chemistry Department,
University of Poznan.
March 26.

[1] Dzialoszynski, L. M., *Nature*, **160**, 464 (1947).

[2] King, E. J., and Armstrong, A. R., *Canad. Med. Assoc. J.*, 376 (Oct. 1934).

Reciprocal Detoxifying Effects of 'Benadryl' and 'Aminopterin'

An attempt has been made to overcome the toxic effect of the 4-aminopteroylglutamic acid, the new powerful folic acid antagonist[1]. Aminopterin is toxic to all laboratory animals used and also to human beings[2-7]. Its toxic effects are difficult to prevent or to reverse by administration of folic acid[6-10], whereas the effects of the X-methyl analogues of folic acid are easily reversed by administration of folic acid[6]. In the experiments reported here, 'Benadryl' was used in an attempt to antagonize the toxic effects of 'Aminopterin'.

Twenty albino mice (mean weight, 25 gm.) were divided in two series, as follows:

	First series	Second series
No. of mice treated	10	10
Single injection of 'Aminopterin' intraperitoneally	1 mgm.	1 mgm.
'Benadryl' subcutaneously	None	0·5 mgm. twice daily
Mortality	10/10	10/10
Death following the injection of 'Aminopterin'	0–1 day 2–2 days 4–3 ,, 4–4 ,,	2–4 days 4–5 ,, 4–6 ,,

These results, although limited, suggest that 'Benadryl' is able to a moderate extent to delay death in mice treated with a single injection of 1 mgm. of 'Aminopterin' intraperitoneally. To determine whether a true relationship might be present between the two substances, experiments were performed to determine the effects of 'Aminopterin' on guinea pigs treated with a lethal dose of 'Benadryl'. The lethal dose of 'Benadryl' varies with the animals used[11,12]. In guinea pigs, the intraperitoneal injection of 40 mgm. per kgm. was often followed by a convulsive state which ended with the death of the animals[13].

Of twenty guinea pigs (mean weight, 625 gm.), ten, used as controls, were given 25 mgm. of 'Benadryl' intraperitoneally. Within ten minutes all the animals went into a convulsive state that lasted about three hours, after which four of them died. The other ten guinea pigs were given 1 mgm. of 'Aminopterin' intraperitoneally, and, ten minutes later, 25 mgm. of 'Benadryl' was given by intraperitoneal injection. None showed convulsions, and all the animals survived. Similar experiments were repeated with twelve guinea pigs (mean weight, 625 gm.) in which a larger dose of 'Benadryl' was used. Six were given 50 mgm. of 'Benadryl' intraperitoneally and all the animals died following severe convulsions. In the other six guinea pigs, 1 mgm. of 'Aminopterin' intraperitoneally was given, and ten minutes later 50 mgm. of 'Benadryl' was injected by the intraperitoneal route. All the animals developed convulsions and only two recovered.

These experiments indicate that 'Aminopter able to prevent the guinea pigs from going int convulsive state and from death when a dose 40 mgm. per kgm. of 'Benadryl' is used. Us larger doses of 'Benadryl', the protective action the 'Aminopterin' is decreased or lost.

V. Traina

Department of Pathology,
Fairview Park Hospital,
Cleveland, Ohio.
Feb. 27.

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South African Fossil Hominoids

Prof. Le Gros Clark[1] seems to have misund stood the point of my communication[2] about South African fossil anthropoids. I have now claimed that "the major dimensions and indices individual teeth can by themselves provide adequ information on which to base statements regard affinities of primitive hominids and anthropoid ap The object of my note was to show that adequ comparisons by proper statistical procedures fai substantiate a commonly stated view that the te of the South African Australopithecine apes di significantly in size and general shape from th of existing apes. Whatever its other purpose, letter may, however, help to underline the objec my communication and of the studies on whic was based.

Both in his letter and in an earlier communicat Prof. Le Gros Clark states that he bases his clusions on a comprehensive view "of the morphological pattern", and that he does not on "a few metrical features considered as iso abstractions". Whatever he may mean by " morphological pattern"—and its meaning canno very much different from the term "constellatio characters" or "character complex" more comm used in taxonomy—it is compounded of an arbit and variable number of different items, and is less an abstraction than the dimensions of indivi teeth. Furthermore, it comprises both metrical "qualitative" features. For example, Prof. Le Clark refers to "the small size (relative and abso and the spatulate form" of the (permanent) can the "small (permanent) incisors" and "the shape dimensions (relative and absolute) of the canine". Most of these attributes can easily be g proper numerical definition. Some others referr by Prof. Le Gros Clark do not lend themselv readily to quantitative statement.

, however many features the "total morpho-
cal pattern" may comprise, each is considered
arately before it is compounded with the rest. It
useful precaution, therefore, to be certain that
metrical attributes which are used in building
distinctive constellations of characters are accur-
y stated. Unfortunately, the three to which Prof.
Gros Clark refers in his letter are not.

Small" and "big" are qualitative words which
uire exact significance in relation to some given
ndard. Prof. Le Gros Clark does not tell us what
e standard is; but he is, in fact, repeating the
servations of Broom, Dart and others who have
ritten about the teeth of the Australopithecinæ, and
all of whom have emphasized the view that the teeth
to which he refers are smaller than the corresponding
e of existing anthropoid apes. In fact, proper
umerical comparisons show this view to be in-
rect, in so far as the extent to which the re-
ded dimensions and indices of the fossil teeth
question diverge from the means of one or other
isting species of anthropoid ape is in most cases
greater than the extent to which, say, one chim-
anzee in twenty will on an average diverge from the
ean of its species, and in no case greater than the
xtent to which one great ape in fifty would diverge
rom its species-mean.

The most extensive set of data about the size of the
h of the Australopithecinæ are given in the 1946
ograph published by Dr. R. Broom[4], and in a
ond monograph on *Plesianthropus* which has just
eared[5]. The claim (e.g., Senyurek[6]) that the upper
ral permanent incisor of *Plesianthropus* is smaller
that of the living anthropoids and that in the
nt of its reduction it parallels later stages of
n evolution is not borne out by adequate com-
ons. The tooth is not significantly smaller than
of the modern female gorilla, and very little, if at
maller than that of the female orang-utan. The
first permanent incisor of *Plesianthropus*, again,
not deviate in size from the female chimpanzee,
male gorilla, or the male or female orang-utan.
ower second incisor does not differ significantly
that of either sex of gorilla, or from the male orang.
e claims that have been made by Gregory and
man[7], Broom[4,5] and Senyurek[6] about the small
f the upper and lower canines of the Australo-
inæ are again not borne out by proper com-
ns, for neither the upper nor the lower perma-
anine diverges significantly in its proportions
hat of the adult chimpanzee.
tly, contrary to Prof. Le Gros Clark's belief,
ilk canines of *Australopithecus africanus* and
hropus robustus do not differ "in shape and
ions, relative and absolute" from the chimp-
while that of *Paranthropus crassidens* does not
e from the orang.

o far, therefore, as these metrical attributes
t as Prof. Le Gros Clark describes them, the
morphological pattern" is not as one would
t to be from his account.

e matters of fact, which are fully elaborated
ere[8] (and not broad questions of primate
eny, about which, to the best of my know-
Prof. Le Gros Clark and I share the same
, were the reason behind the communication
hich Prof. Le Gros Clark commented. His
thus directs further attention to the essential
for a biometric and statistical approach to the
rative study of Primates, unless, of course,
is some other line of attack which can replace exact methods of osteological and odontological study.

S. ZUCKERMAN

Department of Anatomy,
Medical School, Hospitals Centre,
Birmingham 15. June 24.

[1] Clark, W. E. Le Gros, *Nature*, **165**, 893 (1950).

[2] Zuckerman, S., *Nature*, **165**, 652 (1950).

[3] Clark, W. E. Le Gros., *Quart. J. Geol. Soc. Lond.*, **105**, 225 (1950).

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[5] Broom, R., Robinson, J. T., and Schepers, G. W. H., *Transv. Mus. Mem.*, No. 4 (1950).

[6] Senyurek, M. S., *Ann. Transv. Mus.*, **20**, 293 (1941).

[7] Gregory, W. K., and Hellman, M., *Ann. Transv. Mus.*, **19**, 339 (1939).

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A Joule Museum at Manchester

THE support of the University of Manchester and the British Society for the History of Science has been secured for the arrangement of a small museum to commemorate the work of James Prescott Joule, the discoverer of the Law of Conservation of Energy. Besides showing various original instruments and documents which belonged to Joule, it is planned to display reconstructions of the main apparatus used by him in his investigations, and other material illustrating the early history of the discovery.

I should like to appeal to any person or institution in possession of documents, letters or unpublished information concerning Joule, to get into touch with me. I am also interested in any material pertaining to the early relations between Joule and William Thomson (later Lord Kelvin).

L. ROSENFELD

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Phosphorus in Peripheral Nerve

IN a letter published in *Nature*[1], certain observations were quoted on the longitudinal distribution of phosphorus in the sural nerve. Recalculation gives phosphorus contents which do not, in many cases, agree with the previous calculations.

The following are the re-calculated figures.

(1) In nerves stimulated *in vitro* at the distal end, the mean difference between the phosphorus content of the proximal and distal ends is 73 ± 33 μgm./100 mgm. (eleven nerves), and in four cases the distal phosphorus content is greater than the proximal.

(2) In nerves stimulated *in vitro* at the proximal end, the mean difference between the ends is 92 ± 49 μgm./100 mgm. (eight nerves), and in three cases the distal phosphorus content is greater than the proximal.

(3) In fourteen resting nerves the mean difference between proximal and distal ends according to the previously published figures is 4 ± 15 μgm./100 mgm. The recalculated figures show the difference as 6 ± 27 μgm./100 mgm.

As the differences in the stimulated and resting nerves are not significantly different, the conclusions drawn in the paper are not valid.

GILBERT CAUSEY

Department of Anatomy,
University College,
London, W.C.1.

[1] Causey, G., and Werner, G., *Nature*, **165**, 762 (1950).

FORTHCOMING EVENTS

Tuesday, July 25—Friday, July 28

Institute of Physics, Industrial Radiology Group (at the New Horticultural Hall, Victoria, London, S.W.1).—Summer Meeting.

Wednesday, July 26

British Mycological Society (in the Department of Botany, The University, Reading), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Area Gas Examiners (male) in the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3145.TF (July 27).

Hydro-electric Engineer in the Chief Engineer's Department at London headquarters—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting Ref. AE.74 (July 28).

Statistician in the Department of Agriculture, Oil Palm Research Station, Benin, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 (July 28).

Assistant Lecturer in Zoology—The Secretary, The University, Birmingham 3 (July 29).

Assistant Lecturers (2) in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Liverpool (July 29).

Chemists (Scientific Officer and Experimental Officer grades, unestablished) at the Radiochemical Centre, Amersham, Bucks, for the development of new synthetic methods and the preparation of compounds containing the radioactive isotope Carbon-14—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.398/50A (July 29).

Junior Physicist to the Radiotherapy Services—The Secretary, Newcastle-upon-Tyne Regional Hospital Board, Dunira, Osborne Road, Newcastle-upon-Tyne 2 (July 29).

Lecturer in the Electrical Engineering Department—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 29).

Lecturer in Radio Communication—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4 (July 29).

Patent Examiners (with honours degree in physics, chemistry, electrical engineering or mechanical engineering, or an equivalent qualification) in the Board of Trade (Patent Office), the Admiralty, and in the Patent Officer class in the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 3170 (July 29).

Mathematicians (Scientific Officer grade, unestablished) in the Statistical Group of Ordnance Board in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.185/50A (July 31).

Mechanical or Aeronautical Engineers (Experimental Officer grade) at the Royal Aircraft Establishment (Structures Department), Farnborough, Hants, for operational research on aircraft flight load conditions (Ref. C.312/50A), and development of strain measuring technique (Ref. A.173/50A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 31).

Metallurgists (unestablished) at a Ministry of Supply Research Establishment in London: (Ref. F.408/50A) Physical Metallurgists (Scientific Officer grade) with first- or second-class honours degree in metallurgy and research experience in metallography; (Ref. F.409/50A) Experimental Officer or Assistant Experimental Officer (*a*) with an interest in research on refractories, (*b*) for analytical metallurgical work—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 31).

Physical Chemists (Scientific Officer grade, unestablished) at Ministry of Supply Research and Development Establishments in and near London: Senior Scientific Officer (in London) for work in the Industrial Explosives Section, and a Scientific Officer (near London) with a good honours degree in chemistry, and postgraduate research experience desirable—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.399/50A (July 31).

Physicists (Experimental or Assistant Experimental Officer grade, unestablished) in a Ministry of Supply Research Establishment in London, for experimental work with radioactive materials including radiation measurements for health physics and instrument construction, calibration and maintenance—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.189/50A (July 31).

Physicists (Scientific Officer grade, unestablished) with good honours degree in physics and experience in applied physical research, at a Ministry of Supply Experimental Establishment in South-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.183/50A (July 31).

Physicists (Scientific Officer grade, unestablished) at the Royal Aircraft Establishment, Farnborough, Hants, (*a*) for work on display, computor and communication research, (*b*) for work on V.H.F. and U.H.F. navigation, direction finding and landing systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.184/50A (July 31).

Physicists (Senior Scientific Officer or Scientific Officer grade, unestablished) at a Ministry of Supply Research Establishment in London, for the handling and measurement of radioactive materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.188/50A (July 31).

Physicists and Engineers (Experimental Officer grade, unestablished) at the Royal Aircraft Establishment, Farnborough, Hants, for (*a*) development work on electrical and optical apparatus for measurement of flight parameters, (*b*) circuit design and engineering of miniaturized radar equipment, and (*c*) light mechanical and electrical design for work on small servo mechanisms, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.186/50A (July 31).

Entomologist in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (August 5).

Physical Chemists (Experimental Officer grade, unestablished) with an interest in chemical plant development work, at a Ministry of Supply Research Establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.406/50A (August 7).

Senior Experimental Officer (Ref. F/400/50A) for development of methods of ignition of rocket motors, and an Experimental Officer or Assistant Experimental Officer (Ref. C.326/50A) for work on the development of solid propellant rocket motors, and (Ref. D.190/50A) for development, construction and installation of electronic equipment for test and for recording flight parameters, at an outstation of the Royal Aircraft Establishment in Bucks—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 7).

Professor of Physics, and a Professor of Botany—The Registrar, University of Dacca (P.O. Ramna), East Bengal, Pakistan (August 31).

Lecturer in Botany—The Secretary, Queen's University, Belfast (September 15).

Assistant Lecturer (probationary) in Metallurgy—The Registrar, University College, Singleton Park, Swansea.

Botanist for a Tsetse Fly Survey in Nyasaland, to carry out a study of the botanical side of ecology of tsetse fly in conjunction with the Tsetse Entomologist—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Chairmanship of the Department of Bacteriology in the Faculty of Medicine—Dean L. G. Bell, Faculty of Medicine, University of Manitoba, Winnipeg, Canada.

Chemist for work on mushroom composts and related subjects—The Director of Research, Mushroom Research Association, Yaxley, Peterborough.

Inspectors of Mines, H.M. Colonial Service, Nigeria—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27099/13.

Lecturer in Aircraft Structures—The Head of the Aeronautics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

Lecturer in Chemistry—The Clerk to the Governors, Roya Technical College, Salford 5.

Physical Chemist (honours degree in physical chemistry, preferably in electrochemistry or corrosion, desirable) in the Electrochemistry Section of the Coatings Laboratory—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Physicist (with good honours degree in physics and at least one year's research experience)—The Director of Research, British Scientific Instrument Research Association, Sira, Southill, Elmstead Woods, Chislehurst, Kent.

Research Physicist to work on the development of instruments for sampling airborne dusts, especially in coalmines, and on the physical properties of dust particles at rest and moving in an air stream—The Director, Pneumoconiosis Research Unit, Llandough Hospital, Cardiff.

Research Worker to take charge under Head of Nutrition Department of work on the microbiological assay of vitamins and other factors—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

Senior Forecaster (with University degree, preferably in Science and specialized in Meteorology) (Ref. M/N/26337/3E), and Assistant Forecasters (with University degree, preferably in Science and specialized in Meteorology) (Ref. M/N/26338/3E), for the Basrah Port Directorate, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

B.I.O.S. Surveys Report No. 22: The Paint Industry in Germany during the Period 1939–1945. By Neil R. Fisk and H. W. Bowron. Pp. 153+4 plates. (London: H.M. Stationery Office, 1950.) 3*s*. net. [Corrected entry] [274

University of London: University College. Annual Report, March 1948–September 1949. Pp. 233. (London: University College, 1950.) [235

The Bowater Papers. No. 1. Pp. 64. (London: Bowater Paper Corporation, Ltd., 1950.) [255

Other Countries

Ceylon Coconut Quarterly. Vol. 1, No. 1, January–March. Pp. 40. (Lunuwila: Coconut Research Scheme, 1950.) 50 cents. [255

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THE CIVIL SERVICE IN A DEMOCRACY

IN his picture of the administrative staff of the Civil Service which he gave in his Rede Lecture under the title "Portrait of a Profession", Sir Edward Bridges deliberately excluded, for reasons of time, the professional and technical staff in pursuit of their own specialized duties. Nevertheless, his account of the Civil Service tradition is of much interest to scientific men as well as to professional workers generally, whether or not they have been drawn within the ambit of the Civil Service itself, the public corporations or the nationalized industries. Sir Edward's exposition of the distinctive elements in the Civil Service tradition should contribute to a clearer understanding of the human side of the profession and make for more discerning criticism. Although he says little or nothing about the outstanding qualities or virtues of the Civil Service, which in Britain we are too apt to take for granted, some of them are admirably illustrated in the lecture itself. The historical survey of the development of the Civil Service and its tradition, for example, could scarcely be bettered as an example of the capacity of the Civil Service for good writing, to which Sir Hubert Henderson referred at the Conference on Industry and the Universities held at Ashorne Hill last November.

The question is implicit in that comment whether such a standard can be maintained indefinitely if the universities or the schools neglect to inculcate the ability to express ideas clearly in speech or writing ; and we might well ask further whether we can continue to take for granted such acknowledged and conspicuous virtues as incorruptibility, political impartiality and laborious devotion to duty, and not take fuller account of those factors in political or social life, or in what is sometimes termed the climate of opinion, which tend to make their maintenance more difficult. The Prime Minister, in a recent statement regarding the size of the Civil Service, rightly deplored "the fashion now current in some quarters of speaking slightingly of the Civil Service as though its members were less useful members of the community than other people". We might also take note of those factors to which Mr. Maude and Mr. Lewis directed attention in their study of "The English Middle Classes" last year, which make increasingly difficult the maintenance of the cultural and intellectual background and the moral standards in which the Civil Service tradition is most easily nurtured.

The importance of such matters is unmistakable as we follow Sir Edward Bridges through his review of the developing characteristics of the Civil Service, and especially of what he describes as the storehouses of departmental experience. Although the non-political character of the Civil Service received its main imprint in the eighteenth century, the Civil Service as it exists to-day really starts from the reforms instituted by Stafford Northcote and Charles Trevelyan in the middle of the nineteenth century. In the twentieth century the allegiance or affinity of the higher Civil servants to the views of particular ministers has diminished, and their attachment or loyalty to the Service increased; but Sir Edward suggests that the better organisation of the Service during the last hundred years has shown itself most markedly in the greater capacity of the staffs of departments to marshal previous experience and bring it to bear on current problems.

By degrees there has been built up in every department a store of knowledge and experience in the subjects handled, something which may eventually take shape as a practical philosophy, or may merit the title of a departmental point of view. Usually it is the result of nothing more startling than the slow accumulation of experience over the years, and Sir Edward's lecture would be worth reading for this interpretation of such departmental philosophies alone. They express the long continuity of experience which can be one of the strongest qualities of an institution, if well organised. They are broadly based and they are an inheritance which every Civil servant going to a new job ignores at his peril, but which it is his business to extend and improve in his turn.

These storehouses of departmental experience have a bearing on the relationship between day-to-day administration and policy, and Sir Edward's observations in this connexion deserve to be noted in the current discussion on the organisation and staffing of the public corporations or boards, as well as in that on the power of the Cabinet which arose out of Viscount Cecil of Chelwood's motion in the House of Lords on May 17. Sir Edward points out that administration and policy cannot be entirely separated, and decisions in one field cannot be taken independently of the other. It is a cardinal principle of British administration, he reminds us, that no attempt should be made to formulate a new policy in any matter without the fullest consultation with those who have practical experience in that field, and with those who will be called upon to execute the policy.

Ministers are rightly more interested in issues of policy than in detailed administration, but this does not mean that their advisers have no part to play in framing policy. Sir Edward observes that on those broad issues it is the duty of a Civil servant to give his Minister of State the fullest benefit of the storehouse of departmental experience and to contribute the practical knowledge which a Minister can rarely possess. Moreover, he points out that much more could be said about the application of this principle to modern large-scale organisations. With the middle ranks of such large organisations rests the responsibility for ensuring that whatever the head propounds is thoroughly understood by the hands, and that the hands which execute can communicate back to the head. At this middle level, indeed, policy and administration merge and are only distinguished with difficulty.

By this kind of process, writes Sir Edward, administration can be kept in tune with public opinion and the needs of the country. It would not be difficult, however, for an impartial critic to point to instances of distinct hiatus between ministers, if not departments, and public opinion or public needs, and much more might have been added on this point. Sir Edward himself is confident that the departments themselves are working together much more closely, that the fragmentary character of which Stafford Northcote and Trevelyan spoke is passing with the widening of experience. He believes that the growing practice of transfer from one job to another, whether within the same department or between departments, encourages the inter-departmental discussion and co-operation at early stages which the exigencies of economic factors in recent years have compelled. He claims firmly that those who work in Whitehall to-day look over and beyond the boundaries of their departmental loyalties, and see themselves as part of a much larger and more complicated organisation, in which their own job can only be properly done if it takes its place in the fulfilment of the whole.

That is well said, but must not be emphasized to the neglect of the liaison between the executive and the public at large. It cannot be maintained that the introduction of public relations officers and all the paraphernalia of government publicity has yet established ideal relations between the administration and the ordinary citizen, or that the flow of information and understanding from the citizen to the government is any more satisfactory than the flow in the reverse direction. In the concluding part of his lecture, Sir Edward Bridges discusses some of the defects of the Civil servant; but neither there nor in his admirable summary of a Civil servant's job does he quite bring out what is wanted here. The coldly judicial attitude which the Civil servant has to combine with the warmer qualities essential to managing large staffs requires to be inspired also by imagination and a capacity to think himself into the place of the average citizen whose servant he is in reality. It is not just absence of direct responsibility which makes the average Civil servant uncomfortable and infelicitous in his relations with the Press; and one of the greatest needs of our time is a mutual understanding between the citizen and the administrator. This point was well emphasized in the concluding chapter of Mr. H. R. G. Greaves's "The Civil Service in the Changing State".

Sir Edward Bridges's lecture is a fitting complement to the debate initiated by Lord Cecil in the House of Lords, which brought out the importance of understanding the citizen's needs and point of view by the official or the Minister. Although Lord Cecil was concerned primarily with the power of the Cabinet, this is the real issue. The tendency to undervalue personal freedom and to substitute the group for the individual is unconscious rather than deliberate, arising from the diminished sense of personal responsibility and the failure to appreciate the vital importance of securing the interest and understanding of all concerned in any democratic undertaking. Lord Cecil argued that the growing power of the Cabinet and the fresh powers continuously given to the executive, the disappearance of the independent member of Parliament, and the inability of the House of Commons to control effectively the Cabinet, are endangering the whole fabric of Parliamentary government by undermining the interest in and respect of the electorate for Parliament.

The Lord Chancellor, while maintaining that the Cabinet has for the past half-century or more occupied substantially the position it occupies to-day, agreed that the danger to which Lord Cecil had directed attention is real; but he does not think it would be a service to democracy to deprive the Cabinet of its present powers. The real danger to our system of democracy and to freedom lies, he believes, in the possibility that it might not be prompt and swift in action. Lord Simon emphasized more particularly the dangers which follow from the tendency towards increased submission of the ordinary member of Parliament to party leaders and to the enormously increased power in recent years of ministers and departments to guide our affairs by making regulations authorized by a general Act. This practice of delegated legislation gives ministers a power vastly in excess of anything known in previous Parliamentary democratic government in Britain—a power, in effect, to make laws without further effective reference to Parliament at all.

It is the necessity for perpetuating the Emergency Powers Act in this way that Lord Simon challenged; but no speaker put the real dilemma before the House better than the Bishop of Southwell in a speech which recalled some of the argument in Lord Lindsay of Birker's Terry Lectures on "Religion, Science and Society in the Modern World", which stressed the part of the free associations like the universities and the churches in integrating the life of the community. The real question, said the Bishop of Southwell in this maiden speech, is how a strong government, which the dangers facing democratic freedom everywhere necessitate, can avoid overwhelming the liberties which it is trying to defend or demoralizing the community which it is seeking to serve. It is a question not of the power of the Cabinet but of the ever-growing power of the State itself and its mounting claim to omniscience or infallibility. The real problem that democracy has to solve is how to maintain a strong and effective government in being, and simultaneously to preserve the critical independence, virility and initiative of the community on which it rests. Like Lord Lindsay, the Bishop of Southwell suggested that the really effective bulwark against centralized power is the vigour and jealous independence of all those many subordinate societies—clubs, associations of all kinds, professional guilds, trade organisations, cultural foundations, and above all the family—which make up the community on which the State is to rest. A democratic State should take every possible step to stimulate and strengthen these subordinate communities, not forgetting the traditional independence of local authorities. Above all, it is a question of men and women and their status; freedom, in tradition and experience, had always depended in Britain upon a religious valuation of men and women. It has yet to be seen, he said, whether freedom can survive, in any but a formal sense, on any other basis.

That view was strongly supported by the Duke of Montrose and the Marquess of Salisbury. The latter in particular, after urging that it is vital that the authority of both Houses of Parliament should be maintained *vis-à-vis* the Cabinet and the executive if a balance of liberty and authority—which is the basis of ordered freedom—is to survive, referred to the indispensable role of local representative institutions. These, however, are becoming more and more not agencies of local self-government but mere decentralized agents of the central government.

While Lord Addison, who replied, recognized the need of vigilance to safeguard our liberties in respect of departmental and other administrative arrangements, he did not admit the danger of the growing power of the Cabinet. He claimed that Cabinets of to-day are more sensitive to public opinion than ever before; but on the issue of local democracy he made no comment. It is here, however, that the real issue lies, and the Bill for the Better Preservation of the Liberties of the Subject which Lord Samuel afterwards introduced, although purporting to provide a remedy for certain specific abuses or to restore specific liberties, gives Parliament a chance to restate a principle, now largely obscured, that links this whole discussion with the portrait of the Civil Service which Sir Edward Bridges has sketched. Lord Samuel takes the view that although the right of entry into buildings or to suppress or suspend periodicals may not often be abused, the existence of such powers tends to corrupt the proper relationship of the minor official with those whose servant he should be. The clause with regard to public local inquiries should go far to remove some of the friction and bitterness which have attended proposals regarding the acquisition of land for the Services or other public purposes, and it is indefensible that powers to inflict arbitrary fines should be possessed by tribunals which certainly have little resemblance to a court of law.

Some of the other clauses of Lord Samuel's bill may be debatable; but there are enough for Parliament to approve and, in so doing, to restate the principle that no man should be a judge of his own cause, and that accordingly the purpose of laws and regulations is not to make easier the performance by Civil servants of the tasks they have to a large extent set for themselves. If with that it be remembered that the first task of the legislator is to dig deep the channels of assent, it would often be found that the work of digging would establish a contact and understanding between the executive and the public which would make the proposed legislation largely unnecessary. Furthermore, a real effort on the part of the government to promote full and effective public discussion would have other advantages besides providing the basis for building an effective and intelligent public opinion while policy is being formed. It would contribute largely to independent expert discussion and the closer association and the fuller use of the scientific and technical expert in the task of government. With this might go the closer association of those independent groups, from the local government authority downwards, the place of which in active democracy has been under investigation by Political and Economic Planning and was well stressed in the House of Lords debate. Finally, it would help in the linking up of the life of the Civil servant with some of the wide issues of the national life to which Sir Edward Bridges referred as providing one of the abiding satisfactions that offset the disappointments and frustrations inevitable in such a profession.

RADIATIVE TRANSFER IN TERMS OF INTEGRAL EQUATIONS

Radiative Transfer

By Prof. S. Chandrasekhar. (International Series of Monographs on Physics.) Pp. xiv+394. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 35*s*. net.

THE purpose of this book is, according to the preface, to present the subject of radiative equilibrium in plane-parallel atmospheres as a branch of mathematical physics, according to a new method involving the use of non-linear integral equations.

Integral equations have had a somewhat chequered career in mathematical physics. At first the hope was raised that the use of such equations might mean a great strategical advantage in the attack on various formidable mathematical problems presented by Nature. The theory of tides may be a good example (Poincaré), and most of the simpler oscillation problems of hydrodynamics are in the same category. Thus far, however, the differential equations seem to have held their position intact. But, within the special region of radiative transfer problems, the integral equations do provide a competitive way of approach, though even here it may be premature to proclaim the final victory.

It seems that integral equations were first introduced into radiation problems by Hilbert (1912) in a novel proof of Kirchhoff's law. Hilbert even maintained that the integral equations provided the only possible method of proving this law. The following year, L. V. King, in a paper on the Rayleigh scattering of sunlight in the terrestrial atmosphere, showed how the problem could be reduced to the solution of an ordinary linear integral equation of the Fredholm type. Another year after that (1914), K. Schwarzschild showed that the problem of the radiative equilibrium of an atmosphere leads to a Fredholm equation, and Milne, ten years later, extended Schwarzschild's work by showing how different transfer problems all lead to similar types of integral equations. So the matter grew step by step, and in 1934 E. Hopf collected and condensed the available contributions into a neat little book, exceedingly well written, and published as Cambridge Mathematical Tract No. 31.

The present book, which is five times the size of that of Hopf, carries the matter further in various ways. First of all, several introductory chapters are devoted to a careful definition of fundamental terms. The equation of transfer is derived for various representative cases like that of a purely scattering atmosphere with a conservative or non-conservative flux. Diffuse reflexion is considered, and it is shown how to handle problems in which the polarization of the light beam is important. The scattering power of the atmosphere may be either isotropic or anisotropic according to some given law, for example, that of Rayleigh.

Having in this way, so to speak, cleared the deck for action, the next chapters (4–8) are devoted to the development of the method of obtaining solutions by the use of non-linear integral equations. The lack of linearity does not seem to introduce any complications, as the equations may be handled essentially in the Fredholm way by replacing the integrals by a set of ordinary linear equations. The next solution is obtained by passing to the limit of an infinite number of equations, but it appears that in practice one may go a long way with quite a small number of steps. In fact, the original procedure of Schuster of replacing the radiation field by an outgoing and an ingoing stream is, in a certain sense, equivalent to replacing an integral equation by two ordinary linear equations.

Much emphasis is placed on certain novel principles of invariance, which were first formulated by the Soviet astronomer Ambarzumian. Chapter 4 is largely devoted to the discussion of these principles, to which the author concedes such great importance that he says in the preface that "the employment of certain general principles of invariance . . . has been my justification for writing this book". It seems, however, that these principles do not replace completely the physical considerations usually made in the theory of radiative transfer. In some cases, appeal must be made to supplementary considerations in order to make the solution unique (see §§ 61 and 62.2).

The subsequent chapters (9–12) are all in the nature of applications of the general theory as developed in preceding chapters. Chapter 9 is concerned with the problem of diffuse reflexion and transmission, Chapter 10 with planetary atmospheres, and Chapters 11 and 12 contain applications to stellar problems.

The book was planned as a mathematical work on non-linear integral equations, and the author has faithfully stuck to his programme. The inclusion of the two chapters on stellar problems seems to embarrass the author slightly. In fact, in the preface it is suggested that his view was biased in this matter by his astrophysical profession. Considering the fact that the majority of prospective buyers and readers of this book will be astrophysicists, this would seem to be carrying adherence to principles too far.

It will be interesting to watch further developments and to see how far this book will blaze a new trail for the use of integral equations in theoretical physics. Perhaps the change-over from linear to non-linear integral equations, by Laplace transforms or otherwise, may provide a practical way of handling oscillation problems hitherto considered intractable. The fact that the present book establishes a temporary ascendancy of integral equations in radiation theory should act as a strong encouragement for investigations along the same line in other fields. On the other hand, considering the still rather forbidding mathematical formalism required for the presentation of radiation theory in the new way, proponents of other methods of approach have no reason for being discouraged as yet.

The book is written with great care and should not be difficult for the reader, provided he has some taste for mathematical formalism. Inherently abstruse mathematics is generally avoided. The printing is very well done, and misprints are scarce. The author is to be heartily congratulated for having produced a work of high scientific standing, which at the same time has a distinctly personal flavour.

SVEIN ROSSELAND

PHYSICAL METHODS IN BIOLOGICAL RESEARCH

Biophysical Research Methods

Prepared by a Group of Specialists under the Editorship of Fred M. Uber. Pp. xi+667. (New York and London: Interscience Publishers, Inc., 1950.) 76*s*.

THERE are few, if any, volumes dealing with the research methods of biophysics. This American contribution to the subject is addressed in the preface to scientific workers who must resort to physical methods of research for the solution of biological problems, as well as to advanced students. This at once brings us to a contentious point: Should the word 'biophysics' connote chiefly the application of physical methods to biological research? Is it not rather the study of the physical relationships governing the behaviour of living material, which can be a very different subject, even though some of the techniques involved may be common to both interpretations? For example, the technique of measurement of isotopes is a biophysical research method when applied to the measurement of cell permeability; but when used for following a biochemical reaction there is no justification for calling the operation biophysics. A proportion of the volume is devoted to X-rays and ionizing radiation, which are certainly not methods for the study of the normal physical relationships of biological material, however interesting and important may be the effects of ionization on the genes. In short, then, it is suggested that a better title might be "Physical Methods in Biological Research", and the work will have to be criticized from this point of view. The purely physical approach is shown by the fact that it contains no description of biological techniques.

As is inevitable in a compendium written by a number of authors, the degree of thoroughness of treatment of the respective subjects varies very greatly, and there are several gaps or omissions. Thus, one is told in considerable detail, resembling that of the school physics text-book, about scales of temperature, calibration of thermometers, how to set a Beckmann thermometer, and how to connect up a thermocouple in several different ways; but there is nothing whatever about the measurement of diffusion, refractive index, dielectric constant, *p*H, particle dimensions, methods of mechanical recording, X-ray and electron diffraction, surface films, or stimulators. It may be argued in favour of the editor that these subjects are very specialized, but surely no more so than ultrasonic generators or the electron microscope, which do find a place in the book.

The first chapter, entitled "Avoid Fruitless Experiments", contains excellent advice for the beginner in biological research; and the remarks on the values of co-operation in those researches which require complicated equipment could well be taken to heart by some directors of research in universities who, perhaps by reason of research-degree regulations, still tend to discourage joint work.

The chapters all include bibliographies. Those on "Centrifugation" and "Electrons, Neutrons and α-Particles" have the most useful collections, the other chapters often omitting key references, which is regrettable. The descriptions of the methods of measurement are not sufficiently detailed to make the volume more than an introduction to a separate treatise on the individual subject in question, where one exists. It is interesting to see how the various contributors have introduced their pet topics into the text; for example, following the chapter on temperature determination, there are three pages concerning the temperature coefficients of biological reactions and the theories to account for these, which are quite irrelevant. The chapter on calorimetry covers such a variety of topics as the heat production of nerves and of animals, including man, and the use of the bomb calorimeter.

On "Osmotic Pressure Measurements" no mention is made of the osmotic balance of Svedberg or the work of Fuoss. A useful chapter on freeze-drying includes much information on the preservation of viruses and bacteria; but it is a pity that more figures are not available for the conditions of time and temperature required for the treatment of tissue samples. It is a little surprising that the chapter on viscosity does not include any mention of the common methods of determination, namely, the Ostwald tube, the flow method, and the dynamic methods. Some mention might have been made of Perrin's classical work when describing the Brownian movement method. The point made in the same chapter that intact cells rather than extracts should be the subject of study is important and, indeed, may serve to distinguish biophysics from physical biochemistry.

"Bioelectric Measurements" only occupies 38 out of 655 pages and deserves more space. The discussion of electrode potentials in terms of solution pressure is rather dated and would better be put in terms of work function and energy of hydration of the ions (see, for example, Gurney's "Ions in Solution"). More detail and references concerning electrometer amplifiers and direct-coupled amplifiers would be useful; papers by Nielsen, Artzt, Miller and Goldberg should be quoted to provide sources of information on these subjects. A circuit is given for a stabilized power-supply where reference to a published circuit of proved performance would suffice. Only one short paragraph discusses oscilloscopes, and it states that most of them are capacity coupled. This may be true in the United States, but a number of direct-coupled instruments are available in Great Britain, which, perhaps with the addition of a high-impedance input stage, are suitable for laboratory applications. More could be said about the recording of bioelectric phenomena, including such topics as synchronizing the time base of an oscilloscope with a stimulus, and the photography of cathode-ray tube traces.

The chapters on centrifugation and electrophoresis are useful, as is the one on the use of special microscopes. The part dealing with the electron microscope and what can be done with it includes guidance on the organisation of a research requiring use of the instrument. Infra-red and ultra-violet techniques are not mentioned, and indeed there is no description of the ordinary spectrometer. This omission may be justified, but it is peculiar if compared with the fairly detailed description of the microscope in an early chapter and of radiation-dose meters in the following chapters.

It is particularly difficult to review the parts on "X-rays" and "Electrons, Neutrons and Alpha Particles" on account of the specialization in this field. The specimen results for the genetic effects of radiation have a proper insistence on the statistical nature of the process. The latter of the two chapters contains a rather complete description of methods of measurement of ionization produced by various particles as well as numerical data for their ranges in tissue, and an extensive bibliography. It is, accordingly, more potentially useful as a source of reference than the other sections. The discussion of the application of stable isotopes includes descriptions of the mass spectrometer, but not of the densimetric method for the analysis of deuterium and oxygen-18, being content with reference to another work.

The subject of radioactive tracers has been dealt with in several volumes recently, and it is obvious that in fifty pages only limited information may be given. The Lauritsen electroscope is described at some length. There is the almost inevitable sketch of a bell-type Geiger–Müller counter, but no mention of counters for liquid samples, which are of common occurrence in biological work. Nothing is said of the correction which has to be made for dead time of the counting equipment, although other corrections are discussed. Mention might be made of the application of radioactive tracers in chromatography.

In conclusion, I feel that this book should be useful to the student of M.Sc. standard, who wants an introductory survey of some of the physical methods of attacking problems. It is not, nor does it claim to be, a book of reference for practical laboratory work.

E. J. Harris

SELECTION OF LEADERS IN WAR-TIME

The Group Approach to Leadership-Testing

By Dr. Henry Harris. Pp. x+288. (London: Routledge and Kegan Paul, Ltd., 1949.) 21*s.* net.

IT is well known that during the Second World War the British Army developed a somewhat elaborate procedure for the selection by special boards of potential officers. In this book Dr. Henry Harris gives a reasonably full and detailed account of the practices that were adopted and of how and why they were used.

It is interesting and possibly significant that the account begins by a discussion of 'theories'. Maybe this is merely a matter of convenience in exposition; but it is hard to escape from the impression that, first, a general and very speculative view of personality and group functions and relations was accepted (mainly in terms of the 'field theory' of Lewin and others, with a strong mixture of general psychiatry, perhaps largely of a Freudian type) and then all sorts of ingenious ways of illustrating this view in concrete situations were organised and applied. If this is what happened, nobody has any right to complain, for the conditions were urgent and the time short. But the basic problem of how to find sectional leaders remains as important in peace as in war, and, if it is implied that the procedure adopted should remain a model for all subsequent approach, difficulties are bound to arise.

Obviously the justification of any selection procedure must rest mainly upon validation. A chapter on validation of the War Office Selection Board methods, written by Major Gavin Reeve, is included in this book; but it is not satisfactory. It does show that the verdicts reached were, by the accepted statistical criteria, reasonably reliable; but that is not enough, especially in view of the very uniform training given to the essential officers of the selection boards. It shows also that training wastage was substantially reduced, and this, in the circumstances, is a great and important point in favour of the general scheme. But it does not, and indeed cannot, show whether the leaders selected were in later trial significantly better than those picked out in any other way. That this is a critically difficult task anybody with experience, even in much more defined fields of personnel selection, will at once agree; but it is a task that must be attempted when there is time, for it will certainly never be accomplished in an atmosphere of crisis.

On a descriptive level, the book is extremely interesting and well written. It reveals a carefully planned and conducted effort which deserves all the praise—and perhaps some of the blame—which it has received. Very appreciative comments by Sir Ronald Adam and Brigadier Torrie are included, and these two are, beyond doubt, among those who should know.

F. C. Bartlett

ARCHÆOLOGY OF THE BADEGOULE SITE

Badegoule, Station solutréenne et proto-magdalénienne

Par Dr. André Cheynier. (Archives de l'Institut de Paléontologie humaine, Mémoire 23.) Pp. iii+230. (Paris: Masson et Cie., 1949.) 2500 francs.

THE prehistoric site at Badegoule has been known for a long time. Indeed, so long ago as 1906 it was described by Drs. Paul Girod and Massénat, and a section given. These investigators realized that here was an important Solutrean station worthy to be classed with Laugerie Haute. M. Peyrony dug there, and an account of his finds appeared in the *Revue Préhistorique* for 1908. Hauser and the Abbé Bouyssonie also examined the place; but for the period 1928–39 the site was systematically studied by Dr. André Cheynier, who, as a local medical practitioner, was able to give it his continuous attention.

At the base there is evidence of sporadic occupation by Mousterian folk, though the rarity of the finds and the absence of hearths has led Dr. Cheynier to the conclusion that the Mousterians never made the place into a real home. But the importance of Badegoule lies in the extensive Solutrean layers occurring there—no less than six levels. They date from Proto-Solutrean to the latest Upper Solutrean and so give a full range of the culture. Over the latest Solutrean occur two Proto-Magdalenian levels; but these are of no especial interest. The volume is exceptionally well illustrated and will be indispensable to any student interested in the Solutrean 'episode'.

A number of poor engravings, mostly on stone, were found; to what extent the Solutreans themselves were artists, or how far the comparatively few works of art found in their levels were the work of the surviving Aurignacian folk dominated by the invading Solutreans, has long been a problem. It is only fair to say that at Badegoule quite a number of examples have been found, and the levels concerned appear to be purely Solutrean in character. The art is poor and there is much 'scrabbling'; but one or two better-drawn examples of animal figures can be noted.

It is obvious that the explorations and the publication have been a labour of love continuing for many years, and it is excellent that these painstaking and methodical studies are here so well recorded.

M. C. Burkitt

ATOMIC DEFINITION OF PRIMARY STANDARDS

By Dr. R. D. HUNTOON and Dr. U. FANO
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As matters stand to-day, the primary references for all physical measurements are the standard metre and the standard kilogram, preserved at Sèvres, France, and the mean solar day, determined by astronomical observations of the earth's rotation. The standards of length and mass are arbitrary and not independently reproducible. The standard of time is at the mercy of irregularities in the rotation of the earth. Furthermore, there are limits to the accuracy with which one can compare any physical quantity with the primary standards, and these limits are now being felt.

In view of these disadvantages, it is interesting to consider the possibility of selecting other quantities to serve in the place of the present primary standards. In particular, one might select as standards certain immutable properties of atoms or molecules with which other physical quantities can be readily and accurately compared. Any laboratory can rather easily procure samples of the appropriate atoms or molecules. According to present knowledge, such samples would be universally identical.

Recent advances in physical techniques make the use of atomic standards more than an idle speculation, for it is now becoming possible to compare certain physical quantities with atomic or molecular properties more accurately than they can be compared with the present arbitrary standards.

For example, the most precise measurements of length now made in the laboratory rely on interferometric techniques in which the unknown length is compared with the characteristic wave-length of the radiation emitted by certain atoms (such as mercury-198). The resulting uncertainty in the absolute measurement of length now lies primarily in the step where this wave-length is compared with the prototype metre. We can increase the accuracy of absolute measurement of length by adopting the characteristic wave-length as the primary standard and thus omitting metre-bar comparisons. (The prototype metre was not designed, of course, with wave-length comparisons in view.) In fact, work with optical spectra—first with the red line of cadmium and now with the green line of mercury-198—has progressed to the point where the international prototype metre is provisionally defined in terms of the cadmium red line. The International Conference of Weights and Measures held in 1948 [1] endorsed, in principle, the idea of defining the ultimate standard of length in terms of the radiation from an atom such as mercury-198 with an 'even-even' nucleus.

Similar advances have been made in the field of time standards. Recent studies in microwave spectroscopy have led to the development of an atomic clock based on a constant natural frequency associated with the vibrations of the atoms in the ammonia molecule[2].

The recent absolute determination of the gyromagnetic ratio of the proton[3] suggests the possible use of this ratio as a third basic standard. Other physical quantities could then be derived from the three atomic standards by application of suitable electrical techniques.

Thus, we are now in a position to consider the possibility of a complete set of primary atomic standards. Their adoption would remove the need for preserving arbitrary standards and for making whatever corrections are required by irregularities in the motion of the earth. The use of atomic properties as standards offers the additional advantage that they can be measured with increasingly refined techniques, and a growing variety of methods.

The establishment of primary standards based on atomic properties can proceed along the line already suggested by Michelson and Morley[4] for establishing the standard of length in terms of the wave-length of a selected spectral line. Preliminary measurements reported by the National Bureau of Standards, by the National Physical Laboratory, and by the International Bureau of Weights and Measures[5] permit present definition of the metre as 1,831,249·2 wave-lengths of the green radiation characteristic of mercury-198 in standard air. To make it independent of possible variations in air density, the atomic metre should eventually be defined as a number of waves *in vacuo*.

Similarly, the unit of time—the standard second—can be defined as the duration of a certain number of oscillations of an electromagnetic field the frequency of which lies at the centre of some well-defined microwave absorption line. The ammonia molecule has already been used for this purpose in the atomic clock, and work on the use of atomic beam techniques in the microwave range may lead to an even better standard.

The third independent unit could then be based upon the absolute measurement of the gyromagnetic ratio of the proton, making use of these previous definitions of length and time. One might, for example, proceed by defining a unit field-strength of magnetic induction as that field in which protons would precess at the rate of 4,257·84 cycles per second[3].

In principle, all other physical quantities would follow from these three. Actual definitions for the derived quantities would involve a chain of experimental measurements. In the design of the definitive measurements, one may want to exploit the accuracy of length- and time-measurements by means of interference effects. A good example of such an indirect measurement is found in a recent measurement of the velocity of light in terms of the physical dimensions and characteristic frequency of a cavity resonator[6].

It would be rash to claim that the gyromagnetic ratio of the proton, the wave-length of mercury-198, and the absorption frequency of ammonia constitute an immediately satisfactory set of atomic standards. Nevertheless, a large variety of physical quantities may be related to these fundamental standards through workable, moderately accurate procedures.

For example, unit current may be defined by the following procedure. Construct a precision solenoid the dimensions of which are known accurately in terms of the proposed standard metre. Observe proton resonance in the magnetic field of the solenoid while it is carrying direct current. The current is adjusted until the frequency of proton resonance is a certain fraction of the frequency defined by the new standard second. The current flowing under these conditions will then be the new unit of current. To avoid confusion, the dimensions of the coil and the frequency of resonance could be selected to give the present accepted value for the ampere. The charge transported by the new standard current in unit time would then be the new unit of charge.

Similarly, a unit of force could then be defined through the use of a current balance the dimensions of which were referred to the atomic metre, so that the new unit would be the force of attraction between parallel wires when they were carrying unit current. The geometry should be selected to yield the force in terms of the present dyne or newton.

The general procedure which has been discussed here establishes as primary units the 'atomic metre, second, and gauss', or indirectly, the 'atomic metre, coulomb, second, dyne'. (The present four-standard M.K.Q.S. system follows in essence from the three-standard one by taking the permeability of free space as $4\pi \times 10^{-7}$ henry/metre.)

Mass can be derived, of course, from measurements of force and acceleration. Probably the most convenient method at the present time would be a determination of g at the location of the current balance used for force measurements. Other more accurate methods of relating mass to force might be devised.

We thus have in principle a method for deriving all physical quantities from the three suggested atomic standards; but the accuracy with which this process could be carried out is not everywhere satisfactory. Only in the case of the standard of length can present atomic measurements surpass in precision the methods based on conventional standards. The accuracy of atomic time measurements is not yet as good as the accuracy of crystal oscillators corrected by astronomical observations, but the gap is rapidly closing. The accuracy of electric measurements derived from the proton gyromagnetic ratio is still far from adequate, but there is good evidence that this accuracy will improve greatly as time goes on.

It should be pointed out that present-day measurement of atomic constants in terms of currently accepted standards constitutes, in effect, an atomic definition of these standards. Any new standard can be related to the old by a series of measurements on atomic systems. However, when it becomes possible to establish intercomparisons with atomic standards more accurately than with the accepted arbitrary standards, it will be desirable to change from the accepted standards to the new atomic standards. In length measurements, this point has now been reached, and in time measurements it is being rapidly approached. There is good promise that new techniques for the absolute measurement of nuclear gyromagnetic ratios or charge-to-mass ratios will soon put us in this position with regard to the measurement of charge and current.

The present article is intended primarily to direct attention to the possibility of adopting a complete set of atomic standards and to the various questions related to this problem. We hope that further discussion will produce better and more detailed suggestions for achieving these aims.

Even now, one may suggest that the present units be given alternate provisional definitions in terms of atomic systems and that these definitions be revised as experimental techniques improve. When measurements referred to atomic systems become more accurate than those referred to existing arbitrary standards, then the atomic definitions should supersede the arbitrary ones. In the meantime, should some unforeseen circumstance destroy our arbitrary standards, the atomic definitions would provide us with reasonably good substitutes.

For tho purposes of discussion, a set of working definitions consistent with the latest values of the atomic constants, subject to further improvement, can be given:

(1) *Atomic Metre:* The length equal to 1,831,249·2 wave-lengths from the '5460·7532 A.' line of mercury-198 in standard air.

(2) *Atomic Second:* The time required for $238{,}701 \times 10^6$ oscillations of the 23,870 Mc. or 3,3 line of NH_3.

(3) *Atomic Ampere:* The current flowing in an infinite solenoid of 1,000 turns per atomic metre which gives proton nuclear resonance at a frequency of 53,505·6 cycles per atomic second in a sample located at the centre of the solenoid.

(4) *Atomic Newton:* 5 million times the force exerted on each atomic metre length of either of two infinite parallel wires separated by one atomic metre and carrying one atomic ampere.

(5) *Atomic Coulomb:* The charge transported by one atomic ampere in one atomic second.

(6) *Atomic Kilogram:* The mass which experiences an acceleration of one atomic metre per atomic second squared, when acted upon by a force of one atomic newton.

[1] 9th General Conference of Weights and Measures, 1948, Sèvres, France.

[2] Lyons, H., "Microwave Spectroscopic Frequency and Time Standards", *Elec. Eng.*, **68**, 251 (1949). "The Atomic Clock, An Atomic Standard of Frequency and Time", *N.B.S. Tech. News Bull.*, **33**, 17 (1949).

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[4] Michelson, A. A., and Morley, E. W., *Amer. J. Sci.*, **38**, 181 (1889).

[5] Perard, A., and Terrien, J., *C.R. Acad. Sci.*, *Paris*, **228**, 964 (1949).

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RICE PRODUCTION AND UTILIZATION

By H. G. CLOWES

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RICE is the staff of life for more than half the world's population—about 1,000 million people—but, since the War, supplies have fallen perilously low. Pre-war consumption of rice averaged 16–18 ounces per person per day; but until recently barely enough rice has been available to provide 5 ounces per person per day in most of the urban rationed areas of the Far East.

World production of rice in 1949–50 has virtually recovered the pre-war level; but the increase was due largely to expanded production in the minor producing areas, while Asia's rate of recovery still lagged behind the rate of population increase. This gap has been only partially filled by the substitution of wheat and other grains.

The accompanying table shows the production of paddy in 1949–50 by the major producing countries, compared with pre-war and 1946–47.

PRODUCTION OF PADDY (ROUGH RICE) IN THE PRINCIPAL PRODUCING AREAS

Area	Pre-war	1946–47	1949–50*
	(Million metric tons)		
India	32·2	32·7	33·2
China	52·1	47·4	46·7
Pakistan	11·2	12·8	12·3
Indochina	6·5	4·3	5·5
Burma	7·0	3·8	4·2
Indonesia	9·9	7·6	9·9
Japan	11·5	11·5	11·5
Siam	4·4	4·6	5·6
Philippines	2·2	2·2	2·5
Korea	3·9	2·8	3·5
Brazil	1·4	2·7	2·5
U.S.A.	1·0	1·5	1·8
Egypt	0·6	0·9	1·2
Total Asia	142·3	130·8	136·1
Total other areas	7·0	10·2	10·8
World total	149·3	141·0	146·9

* Preliminary.

Good varieties, good cultural and irrigation practices, prevention of disease, improved harvesting methods, storage that prevents loss of grain already harvested, and the best nutritional use of the grain are among the basic prerequisites to better production and consumption of rice. This has been recognized in national and international efforts since the War to increase rice supplies for the Far Eastern consumer.

Good varieties should produce high-grade rice in areas where they are grown, and should have a reasonably wide range of adaptation. Many indigenous varieties in Asia are reported to have a rather narrow range of adaptation, whereas others have a relatively wide range. If the large number of varieties could be reduced to one-tenth or even less of their present number (there are more than two thousand known varieties in India alone) pure seed production and distribution would be much easier to initiate, and breeders could give more attention to the further improvement of varieties grown over large areas.

Good varieties should be resistant to disease, to lodging (especially important as shorter—and stronger—strawed varieties come into demand with increased mechanization), to shattering, and, for specific areas, should be tolerant of saline soils.

Early maturity is important: early varieties require less water. They tend to be shorter-strawed and produce less vegetative growth, making them better adapted to mechanized harvesting. In many cases, earlier maturity would also make it possible to grow two crops each season instead of one. Some of the early maturing varieties yield heavily under favourable conditions, as has been amply demonstrated in India and Japan. The later maturing varieties are, of course, better adapted to some areas and more useful there.

The International Rice Commission (a body representative of seventeen countries which forms part of the U.N. Food and Agriculture Organisation), with headquarters in Bangkok, Siam, is working on projects to improve cultural practices. Better varieties are being developed and better methods of seed distribution proposed. Lack of adequate distribution facilities has slowed the use of improved seed by many Asiatic rice farmers.

The battle against disease and pests of growing rice is partly a matter of planting varieties which are resistant and partly a matter of combating these enemies in the field.

Piricularia oryzæ (or blast) is an important rice disease in India and Japan, where losses range from 10 to 20 per cent in affected areas. Both these countries have developed, by selection from indigenous varieties and from crosses, varieties of rice that are resistant to *Piricularia*. Efforts are being made in Iraq and other nearby rice-producing areas, where damage from *Piricularia* is severe, to import seed of rice varieties which are more resistant to this disease than are local varieties. *Piricularia* in Japan is believed to be related to the low temperature and the high fertility maintained in Japanese soil by the liberal use of nitrogenous fertilizers. This suggests that the disease may become more serious in other Asiatic countries as the use of nitrogenous fertilizers increases, and that a lack of nitrogen fertilizer may be largely responsible for the fact that *Piricularia* and perhaps some other diseases are not apparently important yield-limiting factors in Burma, Ceylon, Indonesia and Siam.

India is also actively working on the *Helminthosporium* disease (brown spot), which causes losses up to 80 per cent in affected areas in years when it occurs in epidemic form. Methods have been developed in India for testing the resistance of rice varieties and selections against this disease.

Stem borers cause enormous losses in rice, especially in South China, where the infestation is very severe in most years. Virtually nothing has been done to investigate the entomological and breeding aspects of insect control in rice. However, the use of resistant varieties should be one of the most successful methods of combating stem borers. It is, of course, very difficult in the present political and economic situation in the East to pursue the steps necessary to the development of varieties resistant to borer.

Among the more unusual pests of rice is a burrowing fish which causes considerable damage to the rice fields of Viet Nam. As reported to the International Rice Commission, by a government representative, the fish (*Gobioides anguillaria*) makes tunnels through the bunds between rice fields as a means of migrating from lower to higher fields. This in many cases results in draining the higher fields and causing severe damage to the rice crops. The counter-attack used against this unusual form of pest is equally unusual. The leaves of the tree *Milletia ichthyochtona* are gathered, and chopped into fine pieces, which are scattered in the water covering the rice-field. A substance in the leaves kills the fish. A small amount of piscidine, an extract of the nut of the same tree, when dropped into the water, is also fatal to these fish. The dead fish, bloated by the gases of decomposition, stop up the tunnels they have bored, and help to prevent further loss of water from the fields.

The tadpole shrimp (*Apus oryzaphages* and *A. biggsi*) invaded a number of rice fields in California in 1946. Young plants were attacked after germination. Young leaves were chewed off, and growth of the seedlings was slowed up by muddying the water in the fields. This pest was effectively controlled by the application of 10 lb. of copper sulphate to an acre of paddy.

Damage to rice during harvesting and storage of the crop is severe but can be controlled. A conference of Asiatic nations, held recently under the auspices of the Food and Agriculture Organisation, estimated that rodents alone are responsible for the damaging and destruction of more than 12 million tons of rice each year. Most of this damage occurs in storage; but large quantities of rice are destroyed in the field. In Indonesia, for example, it has been found that harvesting the rice a little while before it is fully ripe not only saves grain that might be lost by shattering, but also helps to reduce the rat population in the fields. When less scattered rice is left for rats to pick up, the rodents fail to get their usual supply of vitamins necessary for large litters, and their increase is smaller. In many places of the Far East old storage houses are being cleaned and made rodent-proof, and new stores are being built. An old-fashioned method of rodent control is being revived in Malaya. The rice godowns are first surrounded by snakeproof fencing. Then an expedition is made into the nearby jungle to capture pythons, which are given a home under the floor of the godown. There is no rat problem in the godowns policed by pythons.

Efforts have been made by governments to improve handling facilities at the rice mills; but they have not met with complete success. For example, a rice mill in Bangkok has recently completed a modern rice-storage plant on the Chao Phya River. The most up-to-date mechanical process has been installed to unload the paddy by sucking up the grain from the sampans and elevating it into the bins. But many local boatmen have refused to use the modern storage elevator. They are afraid that the boat and all its contents, including the boatman's family, will be drawn into the pipe with the paddy. They prefer to use the conventional and less economical method of unloading by coolies, each coolie carrying two baskets on a wooden yoke balanced across his shoulders. The modern elevator can unload a large sampan with six or eight tons of paddy in less than thirty minutes; but it takes several hours by the more conventional hand method.

Another bottleneck in the rice situation is the unsettled political and economic situation in many areas, such as China, Indo-China and Burma, where rice production has decreased below that of 1949 and 1948. Lack of adequate police protection from roving guerrilla bands has forced rice farmers to abandon temporarily fields some distance from their villages, thus reducing the area under rice. Guerrillas have also caused complete failure of normal transportation systems to bring the paddy to the mill. In Burma, before the War, it was possible to bring paddy down the Irrawaddy River from the rice-growing area north of Rangoon in large barges carrying 1,000–2,000 tons each. Guerrillas and bandits have now made this practice practically impossible. Armed convoys of ten or fifteen trucks must now be organised, each carrying approximately 1·5 tons, to transport rice to the mills. The convoy is often halted by armed men and must pay tribute before passing on. In spite of these difficulties, Burma exported 1,200,000 tons of rice in 1949 to feed people in the Far East; but costs of delivery have increased many times above pre-war.

One way to make the most of rice supplies, of course, is to see to it that the nutrients of rice are preserved and consumed. In an area where the protein foods are scarce, and where beriberi is a common nutritional disease, the Food and Agriculture Organisation has found that milling may cause a loss of 15 per cent of the protein present in husked rice, and as high as 75 per cent of the thiamine, which is essential to prevent beriberi. Rice supplies are frequently so dirty that they require excessive washing in the home. Through excessive washing and improper cooking, 10 per cent of the protein, 10–15 per cent of the calorie value, and 80 per cent of the thiamine may be lost.

The Food and Agriculture Organisation has long recommended under-milling practices, parboiling of rice before milling, educational campaigns for better cooking of rice, enrichment at the mill, and more diversified diets for the rice-consuming people of the world, which represents more than half of the total. The nutritive value of rice strains needs research and continuing consideration in breeding programmes for better varieties.

Dietary changes are taking place in the Far Eastern rice area, including a trend in some sections away from rice as a staple food. This trend has been caused by a scarcity of rice and the economics of the situation. Rice prices have increased six or eight times since before the War, whereas wheat prices have only doubled in the same period. Two tons of wheat can usually be bought for the same price as one ton of rice. A new generation is growing up without the usual dependence on rice. Some authorities believe a number of areas may never again go back completely to rice as a staple cereal.

PHYSICO-CHEMICAL PROPERTIES OF NUCLEIC ACIDS

A SYMPOSIUM on the physico-chemical properties and behaviour of nucleic acids, organised by the Colloid and Biophysics Committee of the Faraday Society, was held at the Institut Français, London, on May 12. The choice of this subject is indicative of the recent growth of interest in the chemistry of nucleic acids. Although nucleic acids were first isolated nearly eighty years ago, it is only in the past decade that some knowledge of the size, shape and structure of these macromolecules has been obtained. The topics dealt with in the symposium were representative of the research in progress in Great Britain and on the Continent of Europe. Prof. E. K. Rideal (London) presided during the morning, and during the afternoon Prof. R. Signer (Berne) and Prof. V. Desreux (Liège) shared the duties of chairman. Abstracts of the papers submitted will be published in the *Transactions of the Faraday Society.*

Ribonucleic acid preparations which have been studied by various physico-chemical techniques, and which have been used in biological studies, are very heterogeneous, and the preparation of homogeneous fractions by electrophoretic and ultracentrifuge methods have proved difficult. By fractionation of samples prepared from yeast, *B. coli*, pancreas and chicken embryo, using the different solubilities in aqueous alcohol, Prof. Desreux has isolated ribonucleic acid fractions which from solubility data appear homogeneous. Two main fractions of ribonucleic acid were isolated in each case, having molecular weights of 50,000 and 5,000. The particles of the high molecular-weight fraction were asymmetric, having an axial ratio of 9 : 1. The physico-chemical characteristics, for example, diffusion and sedimentation constants, axial ratio, electrometric titration curve and solubility, indicate that the fractions of ribonucleic acid prepared from yeast and *B. coli* are similar.

The electrometric titration of deoxypentose nucleic acids was discussed by Mr. D. J. Cosgrove (Nottingham) and Dr. A. R. Peacocke (Birmingham). Mr. Cosgrove described the anomalous titration curve obtained with a sample of deoxypentose nucleic acid which had been prepared by keeping all solutions at or very close to pH 7. Addition of acid or alkali to a solution of the sodium salt at pH 7 does not at first bring about the titration of groups in the pH range 5–11; the titration of groups is delayed until a critical pH region is reached, where the liberation of ionized groups occurs rapidly. The back-titration curves, either from pH 12 or 2·5, are more normal and agree with the calculated curve based on a knowledge of the dissociation constants of the purine–pyrimidine amino groups and —NH—CO— ('hydroxyl') groups. The reaction which occurs on the addition of acid or alkali is irreversible, and a similar change occurs on heating the solution of the sodium salt of the deoxypentose nucleic acid. The anomalous titration curve is not affected by the method of preparation of the nucleic acid so long as treatment with acid or alkali is avoided; this is particularly interesting in that two very different methods of separating the nucleic acid from the protein were employed, namely, the chloroform gel method and the salt precipitation method, and thus confirms the findings of Prof. Signer (see below). Similar titration curves have been obtained for acids prepared from calf thymus, herring sperm and from lamb thymus, and it would appear that the anomalous titration curve is characteristic of all deoxypentose nucleic acids. The anomalous titration curve has been explained by postulating the existence of hydrogen bonds between the —NH—CO— groups and the $-NH_2$ groups of different purine and pyrimidine rings in the acids as initially prepared. Dr. Peacocke pointed out that the titration curves obtained by him did not quite agree with those of Mr. Cosgrove, in that the back-titration curve from pH 12·5 was not identical with that from pH 2·5. The effect of ultrasonic vibration is to produce degradation of the nucleic acid and, like heat and alkaline treatment, to destroy the anomaly in the titration curve.

In the preparation of high molecular-weight deoxypentose nucleic acid, which was described by Prof. R. Signer (Berne), the most important precaution is the inhibition of nuclease activity by cooling to −80° C. and by the addition of enzyme inhibitors. Prof. Signer also considers it is essential that the nucleoprotein prepared by extraction with 10 per cent sodium chloride solution be repeatedly purified by precipitation, which is achieved by diluting the solution to 1·0 per cent sodium chloride concentration. The molecular weight and viscosity are not affected by the method of separating the nucleic acid and protein, and either the chloroform-gel or the salt-precipitation method may be employed.

An X-ray study of nucleosides and nucleotides has been made by Dr. S. Furberg (Oslo), and was described by Dr. C. H. Carlisle (London). In cytidine the pyrimidine ring is flat, and the ribose ring, for which there is some evidence that it is not planar, lies in a plane perpendicular to that of the pyrimidine. The structure of cytidylic acid is similar, the phosphoric acid being attached to the 3′ position. The study of the structure of nucleic acids has been carried to a stage where it is possible to postulate, on the basis of packing considerations, two arrangements of the nucleotides. One is a straight-chain structure, the nucleotides being arranged in the form of a zigzag, and the other is a spiral structure. Both structures give a fibre spacing in agreement with that observed previously by Prof. W. T. Astbury.

Dr. D. P. Riley (London) gave an account of the wide-angle X-ray scattering of solutions of the sodium salt of deoxypentose nucleic acid. At low concentrations, only small-angle scattering is observed but at concentrations greater than 5 per cent there are three distinct regions of refraction at 3–10, 20–50 and 50–200 A. At these rather high concentrations, the solutions are really liquid crystals and exhibit marked domain birefringence. The higher spacings vary as $1/5\ C$, where C is the volume concentration. These data have been interpreted as indicating that the molecules are cylinders of diameter 46 A., presumably formed by the coiling of the long chain; on dilution the separation between the cylinders increases. The scattering which is observed with nucleoproteins is somewhat different, the larger spacing being absent.

The problems involved in the determination of the molecular weight of nucleic acids by means of the ultracentrifuge were considered by Dr. A. G. Ogston (Oxford). Marked molecular interaction makes it necessary to extrapolate the sedimentation and diffusion constants to zero concentration. The sedimentation constant S may be satisfactorily extrapolated as $1/S$ against concentration to give a limiting value for the deoxypentose nucleic acid of calf thymus of $13 \cdot 2 \times 10^{-13}$. The extrapolation of the diffusion constant is performed with the aid of Flory's theory of the entropy of solutions of large particles to give a value of $0 \cdot 55–0 \cdot 70 \times 10^{-7}$. The molecular weight then lies between $1 \cdot 0$ and $1 \cdot 3 \times 10^6$, and the axial ratio is 140–170, which is in reasonable agreement with the value of 190 obtained from viscosity measurements when using a high rate of shear.

Light-scattering measurements on dilute solutions of the sodium salt of deoxypentose nucleic acid were described by Dr. G. Oster (London). The molecular weights of the samples studied varied from 0·51 to $3 \cdot 23 \times 10^6$ according to care of preparation, and were independent of concentration of electrolyte up to 0·2 M. Measurement of the angular scattering with incident and scattered light under polarizing conditions indicates that the nucleic acid particles are rods with strong negative birefringence and are not random chains. Viscosity measurements on the same samples are in accord with the light-scattering results if it be assumed that the diameter of the particle is approximately 40 A. This value, which is in agreement with the X-ray scattering results of Dr. Riley, has been confirmed by some preliminary electron micrographs (made by Mr. H. L. Nixon), which show that the nucleic acid particles are fibres with a diameter of approximately 50 A.

Dr. S. Jungner (Stockholm) then described the dielectric properties of deoxypentose nucleic acids. The molecular weight of a thread-like molecule with a permanent dipole moment such as deoxypentose nucleic acid may be calculated from the anomalous dispersion of the dielectric constant. In nucleic acid the individual dipoles are oriented across the long axis of the molecule, so that the dipole moment is proportional to the number of nucleotides and therefore to the molecular weight. The values of the molecular weight obtained in studies on dilute solutions are somewhat lower than those obtained by ultracentrifuge and light-scattering methods, being in the range $1–6 \times 10^5$. Also in contrast with the light-scattering results is the observation from dielectric measurements that the particle weight decreases considerably to a value of 35,000 on the addition of electrolyte. These results are interpreted as indicating a reversible disaggregation rather than the coiling process hitherto suggested as the cause of the decrease in viscosity. The addition of magnesium ions appears to have a specific effect in bringing about irreversible changes; on precipitation of the nucleic acid with ethyl alcohol in the presence of magnesium ions, large artificial aggregates are formed.

The behaviour of nucleic acids as polymeric electrolytes was discussed by Dr. D. O. Jordan (Nottingham). The nucleic acid polymer contains both strong and weak electrolytic groups, and the presence of the former and the ionization of the latter affect the viscosity of its solutions and the shape of the titration curve. The viscosity of deoxypentose nucleic acid shows considerable structural character, and the viscosity at low pressures is high. The addition of electrolyte reduces the viscosity considerably, as has also been described for simpler systems, for example, polymethacrylic acid and poly N-*n*-butyl-4-vinyl pyridonium bromide. This process is explained by the repulsion of the charged groups (PO^- at *p*H 7) maintaining a stretched polymer in aqueous solution. The addition of electrolyte reduces this repulsion, thereby permitting the molecule to coil, thus producing a more symmetrical molecule and reducing the viscosity, the structural character of the viscosity and the streaming birefringence. The analogy between nucleic acids and synthetic polymeric electrolytes cannot be carried too far, since the number of *gegen*ions absorbed into the micelle is large, as indicated by the value of 550*e* for the charge per molecule in a solution of ionic strength 0·005, compared with the calculated value of 2664*e* for a molecule of molecular weight $8 \cdot 2 \times 10^5$. The presence of the *gegen*ions in the micelle will reduce the number of effective ionized groups, thereby decreasing the repulsion. The dissociation constants are all found to be weaker than in the monomer. Calculation of the *p*K values at different degrees of ionization for the $-NH-CO-$ dissociations shows a decrease in acid strength as ionization increases; the initial value, however, is weaker than that for the nucleoside. This is presumably due to the presence of the PO^- groups. The case of the amino groups is more complicated, the field effect produced by the ionization to NH_3^+ and by the PO^- groups operating in opposite senses.

The degradation of deoxypentose nucleic acids by chemical agents was outlined by Dr. J. A. V. Butler (London). The extent of degradation was followed by measurement of viscosity. The action of X-rays had been shown previously to produce degradation during the irradiation and to give an after-effect in which the degradation continued after the source of radiation had been removed. This after-effect has now been shown not to occur in the absence of oxygen and is probably due to the presence of hydrogen peroxide or HO_2 radicals in solution. A similar degradation to that produced by X-rays may be obtained from the action of free hydroxyl radicals formed by the irradiation of hydrogen peroxide by ultra-violet light or by the reaction between the ferrous ion and hydrogen peroxide. Similar degradation is observed by the action of sulphur and nitrogen mustards. Ultracentrifugal analysis of the degradation products, by Dr. B. E. Conway and Dr. L. Gilbert (London), has shown that there is a considerable reduction of the molecular weight from 1×10^6 to about 1×10^5, the products being very heterogeneous and containing some low molecular-weight fractions which diffuse very rapidly. These degradations, however, are not nearly so extensive as that produced by the action of deoxyribonuclease.

D. O. JORDAN

BRITISH LEATHER MANUFACTURERS' RESEARCH ASSOCIATION

By DR. HENRY PHILLIPS

Director

INCORPORATED in 1920 and starting with a modest income, the British Leather Manufacturers' Research Association at first rented laboratory space for its small staff in London at the Battersea Polytechnic, the Lister Institute and the Imperial College of Science and Technology. Largely the child of the heavy leather industry, the Association rejected the late Prof. A. Smithells's suggestion that its headquarters should be near the Leather Industries Department of the University of Leeds, then guided by Prof. H. R. Procter, because the tanneries in the Leeds area mainly produce light leathers; although scientifically similar, there are fundamental differences between the processes of these two sides of the industry. The Association therefore went to London, where it was near the headquarters of the United Tanners' Federation and the Federation of Light Leather Tanners and Dressers, and also the heavy and light leather industries of Bermondsey.

When Dr. Dorothy Jordan Lloyd succeeded the first director, Dr. R. H. (later Sir Robert) Pickard, the staff was gathered together in laboratories set up in St. Thomas Street, London, S.E.1. Industrial support for the Association grew steadily, and by 1938 sufficient reserve funds had accumulated to enable more commodious laboratories to be furnished in Nelson Square, Blackfriars Road, London. These laboratories were carefully planned and provided a compact and convenient research centre. Occupied in 1939, they were not destined to survive very long, for they were badly damaged in the bombing of 1940, fortunately at night during the absence of the staff. Space for about half the staff was improvised on the ground floor and in the basement of the bombed building; the remainder found accommodation first at Rothamsted Experimental Station and the Leathersellers' Technical College, and later in a large laboratory above the Royal Institute of Chemistry.

At the end of the War, permission to reinstate the laboratories in Nelson Square was refused. The industry was reluctant to move the Association from Bermondsey; but, after the death of Dr. Jordan Lloyd in 1946, a review of the circumstances suggested that the prospects of rehousing within the London area were slight. The Association therefore decided that a search should be made to find a country mansion suitable for conversion and within a radius of twenty miles of London. The final choice fell on Milton Park, a large Georgian-type mansion, situated in thirteen and a half acres of grounds and within walking distance of Egham Station. After a public inquiry, opposition to the conversion was withdrawn. Fairly extensive repairs and modifications to drainage and supply services had to be made; but in a little more than a year the conversion was completed, and the new laboratories were opened by H.R.H. the Duchess of Kent on May 22.

The leather industry is often referred to as a traditional industry, with the implication that the tanner is conservative and reluctant to adopt new methods. This is a superficial view: industries remain traditional so long as scientific knowledge lags behind empirical knowledge. Fibre science and the fibre scientist are relative newcomers to research laboratories: the tanner from time immemorial has been modifying collagen fibres, and until recent times his control over his empirical processes was necessarily precarious. Realizing this, he was naturally reluctant to experiment.

Unlike the textile manufacturer, the tanner obtains his fabrics—hides and skins—already woven; he is essentially a finisher of these fabrics, not only in the sense that he makes the fibres more resistant to water and micro-organisms, but also because he may modify profoundly the physical properties of the fibres. In the manufacture of sole leather, for example, where solidity and firmness are required, the collagen fibres become impregnated with as much as seventy per cent of their weight of vegetable tannins. This transformation is accomplished without serious disturbance of the original fibre weave and pattern. In light leather manufacture, where flexibility is the main consideration, the tanner alters the fibre far less; he is more concerned with decreasing their reactivity by sealing off their amorphous regions and by cross-linking the polypeptide chains.

Such a brief review in terms of modern fibre science could not have been made in 1920. Yet it explains how the past work of the Research Association has followed certain paths to satisfy the tanner's needs. The British tanner has searched the world for hides and skins with fibre structures suitable for specific leathers; thus, a Sudanese sheepskin will yield a gloving leather far superior to that obtained from a merino sheepskin. Methods of preserving hides and skins for transport became, therefore, an early subject for research. So also did the histological examination of all animal hides and skins in order to correlate their fibrous structures with the physical properties of the leathers they gave. Microscopical examination of hides and skins during their conversion into leather was and is still widely studied, so that to-day, for example, the wearing qualities of a sole leather can be assessed from the microscopical examination of a thin cross-section.

The classical work of Procter on the combination of gelatin with acids and alkalis, and the interpretation of the resulting swelling by the membrane equilibrium theory of Donnan, has obvious applications in the leather industry. Investigations in heavy leather tanneries, along the lines now known as operational research, showed that control of the swelling of the fibres in the acid vegetable tan liquors is necessary in order to facilitate the penetration of the tannins into the interfibrillary spaces in the hides. Later investigations revealed the importance of the concentration of acids and salts in the tan liquors as factors controlling the rate at which the collagen fibre structure is loosened to enable tannins to penetrate and become fixed in the fibres themselves. Empirically the tanner had found that, by using blends of extracts of tannin materials from different parts of the world, he could modify the fibres and facilitate the fixation of tannin, although he was unaware that blending gave him the requisite concentrations of acids and salts he required.

Using *p*H control, the tanner can regenerate the weak acids of his tan liquors by the addition of sulphuric acid. The use of strong acids in tanneries was blamed for the tendency of some bookbinding and upholstery leathers to rot and become powdery. Many years of investigation were necessary to prove that the sulphuric acid found in rotted leathers originated from the sulphur dioxide in town atmospheres which was absorbed by leather and oxidized to sulphuric acid under the catalytic action of iron impurities. Treatment of the leather with oxalates or pyrophosphates which sequester the iron makes the leather inert towards sulphur dioxide and hence capable of withstanding polluted atmospheres.

In more recent years the demand for specification of imported manufactured goods in countries anxious to build up secondary industries has caused increased attention to be paid to methods for measuring the physical properties of leather, and this development was taken into account when planning the laboratories at Milton Park: adequate facilities have been installed for the comprehensive study of the physical properties of collagen and leather fibres and of leather in bulk. One of the aims of the Physics Department is to strengthen the morale of the industry, which under the impact of the extensive publicizing of synthetic products has forgotten why it adopted the slogan "There is nothing like leather". This is not surprising, since many men of science are woefully ignorant of the unique properties of the natural fibres and fibrous materials.

Some people have assumed that a model tannery will be erected at Milton Park: nothing could be further from the truth. The liaison department of the Association has many tanneries in which to make extra-mural experiments on existing processes. Radical departures from present methods of leather making which may come in the future will have to be developed before the industry will consider their adoption. For such development work, space is necessary and is now available. Lastly, the recent extension of the work of the Association to include the study of the engineering problems of the industry is not without bearing on future development work.

There are many indications that the Association has moved to its new laboratories at a stage in the development of fibre science which will enable existing processes to be placed under even more rigid control and may lead to the development of new and probably less arduous tanning processes.

OBITUARY

Dr. A. J. Bull

DR. ALFRED JOSEPH BULL, who died on April 15 in his seventy-fifth year, made notable contributions to both photography and geology. From 1903 until 1946 he was associated with the School of Photo-Engraving and Lithography, having been principal since 1912. The advancement in photo-engraving during this period owes much to the research work carried out by Dr. Bull and his colleagues at Bolt Court, Fleet Street. During the Second World War, Dr. Bull and his staff were engaged, among other activities, on a number of special investigations for government departments. Particularly noteworthy was the work leading to the production, on a large scale, of graticules of extremely high precision for a wide range of purposes. Dr. Bull was also a pioneer in colour photography, and enjoyed international reputation as an expert in currency and security printing. He was a founder member of the Institute of Physics, and was president of the Royal Photographic Society in 1933 and 1934, the latter the year of the Fox Talbot Centenary celebrations.

Geology was Dr. Bull's other chief interest. With characteristic thoroughness he attended the full course at the South Western (now Chelsea) Polytechnic and took his B.Sc. in geology in 1917. The following year his work on colour reproduction gained him the degree of M.Sc., this time in physics; but he returned to geology for his Ph.D. in 1937. His original work in geology was mainly in two widely separated fields. For many years he published a series of important papers, either alone or in collaboration, on the geomorphology of the Weald. He was, in particular, a strong advocate of the effects of the cold conditions of the Pleistocene period in moulding the characteristic land-forms of the South Downs. This work was part of the programme of the Weald Research Committee of the Geologists' Association. When the Committee was first formed in 1923, Dr. Bull was elected chairman, and he continued to hold this office until his death. A field meeting of the Association to the Swiss Alps in 1926 stimulated his interest in the problems of major tectonics. He developed theories, notably on the importance of gravity as a geological agent, which were at first regarded critically in several quarters, but which slowly gained increasing recognition.

But this research work, in the leisure moments of a busy life, was not Dr. Bull's sole contribution to geology. He was president of the Geologists' Association during 1926–28, and for many years acted as one of its secretaries. He also served as treasurer of the Mineralogical and Palæontological Societies. Owing to his own expert knowledge and the facilities of Bolt Court, his published papers were enriched by illustrations of the highest quality. In this field he never spared himself in helping others, and the extremely high standard of illustration reached in recent years by several geological journals is largely due to the technical advice and help given so readily and generously by Dr. Bull. J. F. KIRKALDY

NEWS and VIEWS

Prof. J. H. Andrew

It will be a matter of great regret to his many friends in metallurgical circles that Prof. J. H. Andrew, who has been professor of metallurgy in the University of Sheffield since 1932, retires for reasons of health at the end of this summer. A graduate of the honours school of chemistry in the University of Manchester, Prof. Andrew was for some time chief of the Metallurgical Research Department of Messrs. Armstrong Whitworth and Co., Ltd., Manchester, and from 1920 until 1932 he held the chair of metallurgy in the Royal Technical College, Glasgow. At Sheffield he has made widespread changes in the Department of Metallurgy. Obsolete equipment was quickly replaced and the curriculum brought into line with modern ideas. Buildings were extended and modernized by the provision of the Hadfield Laboratories in 1938, while in the post-war years the Department has been almost completely re-equipped, so that its facilities are adequate to meet any demands that teaching or research may make. Prof. Andrew's versatility is shown by the wide field covered by his numerous researches, which include steel making and founding, constitution and transformation of alloy steels, cold-working, gases in metals and related subjects. The recognition of his eminence as a research worker by the award of the Bessemer Medal of the Iron and Steel Institute in 1949 gave great pleasure to the numerous metallurgists he has trained in the method and spirit of research. The important positions throughout the industrial world now occupied by these men testify to the quality of that training. His departure will be felt as a loss in university circles at Sheffield outside his own Department, for both he and Mrs. Andrew have contributed much to the general affairs and social life of the University, and many have reason to remember their generous hospitality.

Physiology at Edinburgh: Prof. D. Whitteridge

DR. DAVID WHITTERIDGE, who has been appointed professor of physiology in the University of Edinburgh in succession to the late Prof. W. H. Newton, has been a fellow of Magdalen College since 1945, and a demonstrator in the Physiology Laboratory at Oxford since 1938. Previously, he had been a Demy of Magdalen, obtaining first-class honours in physiology in 1934, and afterwards pursuing clinical studies at King's College Hospital. He has been a Beit Memorial Fellow and a Schorstein Research Fellow. He is senior secretary of the Physiological Society. Dr. Whitteridge's scientific work has been mainly in nervous and cardio-vascular physiology. He investigated synaptic transmission through the ciliary ganglion with J. C. Eccles. Working during the War on the physiology of blast, he was especially interested in the mechanism of rapid and shallow breathing. He found that it cannot be ascribed to sensitization of stretch receptors, and during the search for other afferent systems he has described the impulses in afferent fibres from the great veins, and a new set of afferent fibres probably arising from the pulmonary vascular bed. After the War, Whitteridge collaborated with Dr. Ludwig Guttmann in studying the cardio-vascular effects of visceral distension in patients with complete section of the spinal cord. This work directed attention to the existence of widespread spinal vascular reflexes in man and to the limitations to the compensatory activity of higher centres. More recently, in collaboration with Dr. Peter Daniel and Miss Sybil Cooper, he has been investigating the afferent impulses arising from mammalian eye-muscles, and is engaged in tracing the central connexions of the afferent fibres within the brain-stem.

Geology at Durham: Dr. K. C. Dunham

DR. K. C. DUNHAM, petrographer of the Geological Survey, has been appointed to the chair of geology at the University of Durham in succession to Prof. L. R. Wager (see *Nature*, June 24, p. 998). Dr. Dunham is a Durham graduate who, following upon post-graduate researches on the geology of the Pennine ore field, spent three years (1932–35) as a Commonwealth Fellow at Harvard University, working principally on the mineral deposits of the Organ Mountains of New Mexico. On his return to Britain he was appointed a geologist on the Geological Survey. His investigations within the Government service have for the most part been concerned with problems of economic geology, work on the Furness iron ore fields of Lancashire and on the lead–zinc–fluorspar–barium mineralization of the Pennines being particularly noteworthy in this connexion. In recognition of the scientific and industrial value of these studies, which have been published principally as memoirs and 'Wartime Pamphlets' of the Geological Survey, Dr. Dunham was awarded the Murchison Fund of the Geological Society in 1942 and the Goldfields Medal of the Institute of Mining and Metallurgy in 1945.

As head of the Petrographical Department of the Geological Survey since 1945, Dr. Dunham has been in charge of the systematic study of British rocks, and has also undertaken a wide range of investigations into the industrial applications of rocks and minerals. Despite these responsibilities, he found time to edit the comprehensive symposium on the geology, paragenesis and reserves of the lead and zinc ores of the world, published by the International Geological Congress in 1948. He takes to the University of Durham the breadth of interest and economic outlook that necessarily characterize the work of the senior officers on the Geological Survey, no fewer than six of whom have preceded him to university chairs within the past five years.

Astronomy at the Australian National University

Dr. R. v. d. R. Woolley, director of the Commonwealth Solar Observatory at Mt. Stromlo, Canberra, has been appointed honorary professor of astronomy in the Research School of Physical Sciences of the Australian National University. By arrangement with the Minister for the Interior, Dr. Woolley will retain his position as director of the Observatory. In announcing this appointment, the vice-chancellor of the University, Sir Douglas Copland, said that students at the Australian National University would now be able to undertake research work at the Stromlo Observatory.

International Scientific Radio Union

The Ninth General Assembly of the Union Radio Scientifique Internationale will be held in Zurich during September 11–22. Sir Edward Appleton is president of the Union which, in accordance with resolutions passed at the previous Assembly in Stockholm in 1948 (see *Nature*, 163, 493; 1949), now organises its scientific work under seven commissions, the titles and presidents of which are as follows: (1) Measurements and Standardization, Dr. J. H. Dellinger (United States); (2) Troposphere and Wave Propagation, Dr. C. R. Burrows (United States); (3) Ionosphere and Wave Propagation, Sir Edward Appleton (Great Britain); (4) Terrestrial Atmospherics, Prof. H. Norinder (Sweden); (5) Extra-terrestrial Radio Noise, Dr. D. F. Martyn (Australia); (6) Waves and Oscillations, Prof. Dr. van der Pol (Netherlands and vice-president of the Union); (7) Electronics, Dr. G. Lehmann (France). The British National Committee for Scientific Radio is organised under the auspices of the Royal Society as a constituent member body of the Union Radio Scientifique Internationale. This Committee has nominated the following British delegates to the forthcoming general assembly, the numbers of the commissions to which they are specially responsible being indicated in brackets: Mr. C. W. Oatley (1), Dr. R. L. Smith-Rose (2), Dr. W. J. G. Beynon (3), Dr. J. W. Findlay (4), Dr. A. C. B. Lovell (5), Group-Captain W. P. Wilson (6), and Prof. J. Sayers (7). In addition, a small number of observers has been appointed by the Committee to attend the meeting in Zurich.

In accordance with established procedure, the various national committees will submit to the General Assembly progress reports reviewing the advances made within their own countries in each of the fields of research designated by the seven commissions. These reports will be supplemented in some cases by short original contributions describing recent research work of direct interest to the international aspects of scientific radio. National delegations may also submit any proposals for international action, which may include theoretical and experimental research, and, where desirable, standardization of equipment and nomenclature. Certain proposals of this nature have already been submitted to the Union by the Comité Consultatif International des Radio-communications, which is a technical committee responsible for advising the International Telecommunications Union on all aspects of practical radio communication. This arrangement forms a very satisfactory liaison whereby the fundamental problems confronting the practical engineer may be brought to the notice of the man of science, who may then be expected to seek a solution.

Prehistory of Africa

For many years, Mr. E. J. Wayland was the Government geologist in Uganda, and it is safe to say that there is no one who knows more than he does of the complicated geological structure and tectonics of that country. Not unnaturally, he has also concerned himself with the problems of the prehistory of the region, since it abounds with the relics of Stone Age man. He had, indeed, intended to write a definitive work on the matter, and for this purpose had made extensive collections of stone tools; but then came the Second World War and everything had to be put off. In the meantime, too, a book called "The Prehistory of the Uganda Protectorate" had been published by T. P. O'Brien. But many of Mr. O'Brien's conclusions are not accepted by Mr. Wayland, and it is still very much to be hoped that he will publish his considered opinions on the very complicated problems which the country presents. As something to be going on with, however, he has published some notes (*S. African Arch. Bull.*, 5, No. 17, March 1950), all of which are worth while and stimulating. With reference to the Kafuan industries of Uganda, for example, he alludes to his prolonged searches for the original source of the earliest tools, which he says were finally run to earth in laterite ironstone deposits of the End-Tertiary peneplain, and may therefore be of the order of a million years old; and he has some astonishing figures about the prolificacy of implementiferous pits which he sank at Nsongezi in the Kagera valley. To these thought-provoking notes he has added a number of pages of his ideas on man and the Kalahari Desert and stone age research in Bechuanaland, with a list of basic considerations that he feels are important, and the Stone Age sequence in the latter country. Desmond Clark, of Livingstone, has recently concluded an extensive study of the Zambesi gravels and prehistoric man, and investigations of the Kalahari sands in Angola and their relation to Stone Age man are also taking place, so it is much to be hoped that a pooling of ideas in these fields will be possible and some definitive conclusions reached.

Unsaturated Polyester Resin for Biological Use

The March number of the *Museums Journal* includes a paper by P. E. Purves and R. S. J. Martin, of the British Museum (Natural History), describing some techniques that they have recently developed with a series of resins of the unsaturated polyester class. The resins of this type are marketed in Great Britain under the trade name of 'Marco Resins', and one of these, namely, 'Marco Resin' *S.B.* 26*C*, has many characteristics which make for general use in biology. *S.B.* 26*C* has a fair degree of transparency and is fortunately nearly colourless in the polymerized state. It polymerizes at ordinary temperatures without special apparatus, is completely anhydrous and is thus suitable for wet specimens. It can be used as an embedding medium in three types of mount: the wet mount, in which specimens are embedded directly from water; the cleared mount, in which soft tissues and some bones are rendered transparent; and the dry mount, which is mainly suitable for osteological and mineralogical specimens. *S.B.* 26*C* can also be used as an injection medium. Formulæ and details of the procedure for both uses of this resin are given in the paper.

British Journal for the Philosophy of Science

It seems unlikely that the present trend of scientific activities is going on unobserved by acute minds. Its characteristic feature is that the individual has largely been replaced by the team. Applied physics, for example, requires corporate effort rather than lone strife and solitary meditation. Awareness of these things has helped to bring to birth the *British Journal for the Philosophy of Science*—a quarterly which made its first appearance in May (Edinburgh and London: Thomas Nelson and Sons, Ltd. 7*s.* 6*d.*; annually, 30*s.*), in an attempt to deal with the basic, yet wide, aspects of science. That it should have started life at this particular time is significant; the need is to integrate the more profound personal problems of our generation—ethical, religious, æsthetic—into some coherent pattern congruent with experience in a scientific age. The first number sets a high standard. It contains articles on the theory of measurement, the development of the theory of science, Descartes and the mind–body problem, and metaphysical interpretations. Appropriate space is also provided for reviews. The policy of the managing committee, assisted by a distinguished editorial board, will be to publish contributions the primary datum of which is science, with particular reference to its philosophical implications. Historical aspects will not be overlooked. In view of the marked interest recently awakened at the universities of Britain in studies of this kind, the new journal should quickly find willing readers and competent contributors. That the response from authors qualified to write has, in fact, been considerable suggests that a very high level can be demanded. The founders are well aware of the tendency to fall away, and are taking every precaution to prevent it. They and their publishers are entitled to congratulations upon a brave effort, worthy of all possible support.

Vitamin K and Prothrombinæmia

In the second volume of *Publicaciones de Medicina Experimental* of the University of Chile (pp. 324; Santiago: Universidad de Chili, 1947), Dr. Ismael Canessa discusses the history, chemistry, physiology and functions of vitamin K and the symptoms and pathology and other aspects of prothrombinæmia. The paper, which is 304 pages long, occupies most of this volume. The remainder of the publication is given to a shorter paper on the level of circulatory prothrombin and the effect of splenectomy on it, with a note suggesting a chemical formula for fibrinogen.

Science and the World's Food Supply

A course on "Science and the World's Food Supply", organised by the Educational Centres Association, will be held at Westham House, Barford, near Leamington, Warwickshire, during August 26–September 2, under the general supervision of Dr. M. H. Clifford, tutor and lecturer in natural sciences, Cambridge University Board of Extra-Mural Studies. This course is designed to bring together laymen and men of science to study some aspects of the contribution that science can make to the increase of human well-being, and will deal with the application of science to the problem of increasing the world's food resources. There will be a series of evening lectures by visiting speakers dealing with the industrial and biological aspects of food processing. Members of the course will be able to make their own individual contribution to the subject at tutorial discussions, and there will be a visit to an agricultural research station. The cost of the course is £4 15*s.*, which includes board, residence and tuition. Further information can be obtained from the Summer School Secretary, Educational Centres Association, 8 Endsleigh Gardens, London, W.C.1.

Paris Congress on Electron Microscopy

A congress of electron microscopy will be held in Paris during September 14–22. It is being organised by the Société Française de Microscopie Théorique et Appliquée, and the work will be divided into five sections: electron optics and microscopes, electron diffraction, metallurgical applications, chemical applications, and biological applications. Two exhibitions are being arranged to be held during the congress, the first to illustrate the history of the development of the electron microscope, and the second to give examples of recent work with the instrument. Laboratory visits and excursions to different parts of France are also being planned. The official language of the congress will be French; but texts can be presented in English. A detailed programme can be obtained from the Congress Secretariat, Laboratoire de Cryptogamie du Muséum National d'Histoire Naturelle, 12 rue de Buffon, Paris 5e.

Summer School on the Physics and Chemistry of Free Radicals

A summer school on the "Physics and Chemistry of Free Radicals" will be held in the University Department of Physical Chemistry, Cambridge, during August 19–26. Courses of lectures and demonstrations will be given on: structure, spectroscopy and mass-spectroscopy of free radicals; free radicals produced by light and nuclear radiation and their reactions; role of free radicals in combustion and polymerization; and free radical reactions in solutions. Men can be accommodated in college rooms. Further details and forms of application may be obtained from the Secretary of the Summer School, Department of Physical Chemistry, Free School Lane, Cambridge.

University of London: Appointments

The following appointments in the University of London have been announced: Dr. E. R. Leach to the University readership in anthropology tenable at the London School of Economics and Political Science; Dr. W. L. G. Gent to the University readership in physical and inorganic chemistry tenable at Guy's Hospital Medical School; and Dr. A. T. J. Dollar to the University readership in geology tenable at Birkbeck College. The title of professor emeritus in the University has been conferred on the following: Prof. A. J. Allmand, on his retirement from the Daniell chair of chemistry at King's College; Sir Cyril Burt, on his retirement from the chair of psychology at University College; and Prof. R. O. Kapp, on his retirement from the Pender chair of electrical engineering at University College. The title of reader in physics in the University has been conferred on Dr. O. E. H. Klemperer in respect of the post held by him at the Imperial College of Science and Technology.

University of Birmingham: Appointments

THE following appointments in the University of Birmingham have been announced: Prof. A. Boyce Gibson, professor of philosophy in the University of Melbourne, to be professor of philosophy in succession to Prof. L. J. Russell, who is retiring; Dr. S. C. Redshaw to be professor of civil engineering in succession to Prof. C. Batho, who is retiring; E. B. Edney, lecturer in zoology, to be reader in entomology; D. A. Bell, lecturer in electrical engineering, to be reader in electromagnetism; W. Carnegie, of the Pametrada Research Station, Wallsend, J. W. Railly, of C. W. Parsons and Co., Ltd., and F. E. Kras, of the Northampton Polytechnic, lecturers in mechanical engineering; Dr. R. Schneider, lecturer in experimental therapeutics.

The Night Sky in August

NEW moon occurs on August 13d. 16h. 48m., U.T., and full moon on August 27d. 14h. 51m. The following conjunctions with the moon take place: August 11d. 15h., Venus 5° S.; August 15d. 18h., Mercury 2° S.; August 15d. 20h., Saturn 1° N.; August 19d. 04h., Mars 3° N.; August 27d. 12h., Jupiter 1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Regulus on August 1d. 11h., Mercury 0·5° N., and on August 16d. 22h. Mercury is in conjunction with Saturn, Mercury 3·5° S. Mercury sets less than an hour after the sun on August 1 and attains its greatest eastern elongation on August 21; the planet is too close to the sun for favourable observation during the greater portion of the month. Venus rises about two hours before the sun throughout August and is conspicuous during the early morning hours, more than nine-tenths of the illuminated disk being visible through the greater part of the month (stellar magnitude −3·3). Mars sets at 22h. on August 1 and 20h. 40m. on August 31, and is drawing rather close to the sun after this for favourable observation. Jupiter rises soon after sunset and is visible throughout the night in the constellation of Aquarius; the planet is in opposition on August 26. Saturn sets at 21h. 10m. on August 1 and is too close to the sun for favourable observation during most of the month. Occultations of stars brighter than magnitude 6 are as follows: August 7d. 03h. 41·5m., 23 Taur. (*D*); August 30d. 23h. 48·4m., ε Pisc. (*D*); Aug. 31d. 00h. 49·1m., ε Pisc. (*R*). *D* and *R* refer to disappearance and reappearance respectively, and the latitude of Greenwich is assumed.

Announcements

PROF. F. C. STEWARD, professor of botany in the University of Rochester, New York, formerly lecturer in Birkbeck College, London, has been appointed a professor of botany in Cornell University as from September 30.

DR. S. A. BARKER, of the University of Birmingham, has been appointed Mackinnon Research Student of the Royal Society. He will work on the enzymic synthesis of polysaccharides.

MR. L. M. JACKMAN (University of Adelaide) has been elected to a Beit Fellowship for scientific research of the value of £500 per annum, tenable at the Imperial College of Science and Technology, for research in organic chemistry under the direction of Prof. R. P. Linstead.

MR. D. G. GILLAM (University of Melbourne) has been awarded an Overseas Science Scholarship by the Royal Commission for the Exhibition of 1851, in place of Mr. L. M. Jackman, who has accepted a Beit Fellowship (see above). Mr. Gillam will carry out research in physical chemistry at the Royal Institute of Technology, Stockholm.

THE Committee of the Privy Council for Agricultural Research and Nature Conservation has reappointed Mr. T. Dalling and Dr. Joseph F. Duncan to be members of the Agricultural Research Council for a further term, and have also appointed Prof. S. C. Harland to be a member in the vacancy caused by the retirement from the Council of Sir David Brunt.

MR. ARTHUR MASON, formerly a textile consultant in London, has been elected an honorary life member of the Textile Institute.

IT is announced by the University of Leeds that Mr. A. F. Maloney has been appointed to the newly instituted post of lecturer in neuropathology; and Mr. B. W. Wyke has been appointed lecturer in physiology. Messrs. Brotherton and Co., Ltd., have renewed for seven years their gift of £1,000 a year for maintaining a research lecturer and research assistant in chemical engineering in the University.

THE Society of Physical Chemistry proposes to organise annually a meeting of several days duration for the discussion of a specific topic. In 1951, the meeting will take place in May, and the topic will be "Transferts électroniques en solutions et aux électrodes". Titles of communications must be submitted before December 31, 1950, and the complete papers by February 15, 1951. Further information can be obtained from the Secretary, Dr. G. Emschwiller, École Supérieure de Physique et de Chimie, 10 rue Vauquelin, Paris (5e).

THE ninth General Assembly of the International Union for Geodesy and Geophysics will be held in Brussels during August 21–September 1, 1951. The provisional programme includes a symposium on the study of the ocean bottom, and joint meetings of different sections to discuss the physics of the upper atmosphere and ionosphere; general circulation of the oceans and the atmosphere; movements of the earth's crust; and nature of the earth's core

THE New Zealand Council of Scientific and Industrial Research is offering a postgraduate scholarship to enable a British graduate in science or engineering to spend two years in the Dominion. Hitherto, New Zealand students have come to Britain; but it is believed that the natural resources and climatic conditions of New Zealand provide unusual opportunities which would appeal to an overseas student. Particulars can be obtained from the New Zealand Scientific Office, Africa House, Kingsway, London, W.C.2.

CONFIGURATION OF CARBOHYDRATES, HYDROXY-ACIDS AND AMINO-ACIDS

Stereochemical Standards of Configuration

THE agreed standard by reference to which configurations are expressed in the carbohydrate and hydroxy-acid series is glyceraldehyde, the (+)-form of which is 'D' by definition. By the use of transformations which do not change any bond of the asymmetric carbon atom, it has been shown, for example, that (+)-tartaric acid, (+)-malic acid, (−)-lactic acid, and (−)-glyceric acid all correspond in configuration to (+)-glyceraldehyde. It follows that all are D-compounds on the glyceraldehyde standard.

The agreed standard of reference for the expression of configurations in the series of peptides and amino-acids is serine, the (−)-form of which (the 'natural' form) is 'L' by definition. By the use of reactions which do not break a bond at the asymmetric centre, it has been shown, for example, that (+)-alanine, (−)-asparagine, (−)-cystine, (+)-valine and (−)-tyrosine agree in configuration with (−)-serine. It follows that all are L-compounds on the serine standard.

The question of the relationship between these two standards has engaged attention. It has been made plausible by arguments from molecular rotations, and assumed chemical analogies, that the standards agree[1-4]. But it has been emphasized that such arguments are not conclusive[3,5]. For this reason it has become conventional to specify the standard employed, whenever there could be any doubt, by means of the subscripts 'G' and 'S' (meaning glyceraldehyde and serine) in designations such as 'D$_G$' and 'D$_S$'.

Clearly, it would be convenient if the two standards could be firmly connected, especially in view of the extensive merging, for example, in amino-sugars, of the carbohydrate and amino-acid fields of investigation, and because of the frequent need for expressing configurations about more than one asymmetric centre. We are indebted to Dr. A. Neuberger for directing our attention to this problem, and to Dr. R. S. Cahn for much further information emphasizing its general importance. As a direct consequence of these conversations, we realized that we had in our unpublished records the result needed for its solution.

In his recent review[3] of the stereochemistry of amino-acids, Neuberger discusses the problem of correlating the two standards; and he points out that this problem could be solved by our kinetic method. Actually we have solved it in this way, as is recorded in summary below.

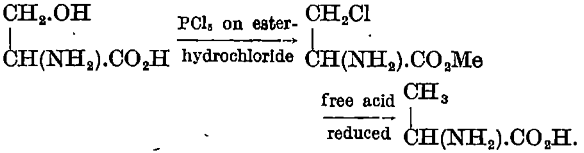
The method is based on the well-established principle[6] that, independently of all structural details, bimolecular nucleophilic substitution leads to inversion of configuration. In applying the method, the chief task always is to prove kinetically that such substitutions at an asymmetric centre as are involved in the establishment of a genetic connexion between given optically active substances are, indeed, bimolecular nucleophilic substitutions (S_N2).

There are five stages, most of them composite, in the genetic route between glyceraldehyde and serine. They are indicated in the following scheme, which also shows the configurationally corresponding signs of rotation of the different substances (the symbol ∼ means 'corresponds in configuration to'):

(+)-glyceraldehyde $\underset{(1)}{\sim}$ (−)-glyceric acid $\underset{(2)}{\sim}$ (−)-lactic acid $\underset{(3)}{\sim}$ (+)-α-bromopropionic acid $\underset{(4)}{\sim}$ (−)-alanine $\underset{(5)}{\sim}$ (+)-serine.

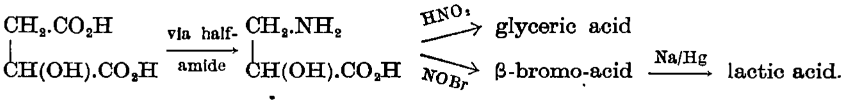
Stages (1), (2) and (5) were covered by work which is now classical: the method was always to modify groups without breaking a bond at the asymmetric centre. Stage (3) was covered by Cowdrey, Hughes and Ingold during the development of the kinetic method. The whole road between glyceraldehyde and serine is now opened by the completion of stage (4). The stages are described in historical sequence.

Stage 5. Fischer and Raske (1907) converted (−)-serine into (+)-alanine as follows[7]:



$$\begin{array}{l}CH_2.OH\\ |\\ CH(NH_2).CO_2H\end{array} \xrightarrow[\text{hydrochloride}]{PCl_5\text{ on ester-}} \begin{array}{l}CH_2Cl\\ |\\ CH(NH_2).CO_2Me\end{array} \xrightarrow[\text{reduced}]{\text{free acid}} \begin{array}{l}CH_3\\ |\\ CH(NH_2).CO_2H.\end{array}$$

Stage 2. Freudenberg (1914) converted (−)-malic acid, through *iso*serine, (*a*) into (+)-glyceric acid, and (*b*) into (+)-lactic acid[8]:



$$\begin{array}{l}CH_2.CO_2H\\ |\\ CH(OH).CO_2H\end{array} \xrightarrow[\text{amide}]{\text{via half-}} \begin{array}{l}CH_2.NH_2\\ |\\ CH(OH).CO_2H\end{array} \begin{array}{l}\xrightarrow{HNO_2} \text{glyceric acid}\\ \xrightarrow{NOBr} \beta\text{-bromo-acid} \xrightarrow{Na/Hg} \text{lactic acid.}\end{array}$$

Stage 1. Wohl and Schellenberg (1922) converted (+)-glyceraldehyde into (−)-glyceric acid by direct oxidation with mercuric oxide and alkali[9].

Stage 3. Cowdrey, Hughes and Ingold (1937) converted (+)-α-bromopropionic acid into (+)-lactic acid by alkaline hydrolysis under conditions which were kinetically controlled to secure an S_N2 reaction, that is, an inversion of configuration[10].

Stage 4. We have converted (+)-α-bromopropionic acid into an α-azidopropionic acid by reaction with sodium azide under conditions which were kinetically controlled to yield an S_N2 reaction (k_2 in water at 50·0°, $8 \cdot 29 \times 10^{-4}$ sec.$^{-1}$ gm.-mol.$^{-1}$ l.), and therefore an inversion of configuration. Then we reduced the azido-acid by Adams's method to (+)-alanine, a process which does not break any bond at the asymmetric centre, and accordingly must retain configuration. The overall result must therefore be inversion. The same overall result was obtained by proceeding through the methyl ester of (+)-α-bromopropionic acid and the corresponding azido-ester. Experimental particulars will be published later.

This completion of this genetic chain between glyceraldehyde and serine establishes the relations

DG ~ DS and LG ~ LS; that is, the two standards agree.

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[1] Frankland, *J. Chem. Soc.*, 713 (1933).

[2] Freudenberg, "Stereochemie", 317 (1933).

[3] Neuberger, "Advances in Protein Chemistry", 4, 297 (1948).

[4] Wolfrom, Lemieux and Olin, *J. Amer. Chem. Soc.*, 71, 2874 (1949).

[5] Lowry, "Optical Rotatory Power" (1925).

[6] Cowdrey, Hughes, Ingold, Masterman and Scott, *J. Chem. Soc.*, 1252 (1937).

[7] *Ber.*, 40, 3717 (1907).

[8] *Ber.*, 47, 2027 (1914).

[9] *Ber.*, 55B, 1404 (1922).

[10] *J. Chem Soc.*. 1208 (1937).

Configurations of Amino-Compounds and the Steric Course of Deamination

IT was shown in 1937[1] that a Walden inversion could be firmly located in a series of chemical changes, that sign of rotation could be connected with configuration, and that the incidence of Walden inversions generally could be reduced to rule, by consideration of the two kinetically distinguishable mechanisms, S_N2 and S_N1, of aliphatic substitution, which had been recognized somewhat earlier. The rules for the steric course of substitution were as follows:

S_N2. Substitution by this mechanism involves inversion of configuration, independently of all constitutional details. This rule, which has theoretical as well as experimental justification, is so definite that it can conveniently be used in order to relate sign of rotation to configuration.

S_N1. This mechanism proceeds through a carbon cation, and involves racemization, possibly with some excess of inversion, unless a configuration-holding group, such as the α-carboxylate ion group, is present, when configuration is retained. Winstein has since shown[2] that suitably situated neutral groups with active unshared electrons can similarly lead to a preserved configuration. Dr. A. G. Davies has recently found[3] that even double-bond π-electrons can exert an effect in the same direction.

The classical work on the Walden inversion related mainly to interconversions between the following three types of compound: (*a*) *R*Cl, *R*Br; (*b*) *R*OH, *R*OAlk; (*c*) RNH_2. The above rules were applied in 1937 entirely to interconversions between compounds of types (*a*) and (*b*). We have now applied them to interconversions between either of these series and series (*c*). This allows us to relate the signs of rotation of amines to their configurations, and thus to interpret with certainty the stereochemical course of many transformations which form or destroy amino-compounds.

The first step was to establish the relation of sign of rotation to configuration for a representative series of amines by the use of the above S_N2 rule. This was done with reference to the corresponding halides, by the general method exemplified in the preceding note:

$$R\text{Hal} + N_3^- \xrightarrow[\text{controlled } S_N2]{\text{kinetically}} RN_3 \xrightarrow[\text{Pt}]{H_2} RNH_2 \text{ (overall inversion).}$$

The work of 1937 established the relation of sign of rotation to configuration for the corresponding alcohols and ethers, with respect to the halides. Therefore the new work extends the correlation over the three series, (*a*), (*b*) and (*c*). Configurational correspondence has thus been proved, *inter alia*, within each of the following sets of compounds, *RX*, with the same *R* and variable *X* (C_6H_{13} means *n*-hexyl):

RX	*X*				
	Cl	Br	OH	OEt	NH_2
$C_2H_5.CHX.CH_3$	(+)	(+)	(+)	..	(+)*
$C_6H_{13}.CHX.CH_3$	(+)	(+)	(+)	(+)	(+)*
$C_6H_5.CHX.CH_3$	(+)	(+)	(+)	(+)	(+)*
$CH_3.CHX.CO_2H$	(+)	(+)	(−)†	..	(−)
$C_6H_5.CHX.CO_2H$	(+)	(+)	(+)	..	(−)

* Rotations refer to the pure liquids.
† These hydroxy-acids have (+)-salts.

The next step was to examine the rotatory changes which accompany deamination of each of the above amines. Relevant work on the amino-acids is already on record[4], but very little significant work on the amino-hydrocarbons has been reported. In supplementing the available data, we have examined the following deamination processes (the second of which has been but little studied hitherto):

$$\begin{array}{llllll} RNH_2 & + \ HNO_2 & + \text{ acid} & + \ H_2O & \longrightarrow & ROH \\ \;\;'' & + \ \;\;'' & + \;\;'' & + \ EtOH & \longrightarrow & ROEt \\ \;\;'' & + \ NOCl & + \ HCl & + \ H_2O & \longrightarrow & RCl \\ \;\;'' & + \ N_2O_3 \text{ or } NOCl & + \ HBr & + \;\;'' & \longrightarrow & RBr \end{array}$$

After translating the observed rotations into terms of configuration with the aid of the results noted above, the outcome of this work can be reduced to the following summary (In = inversion, Rt = retention of configuration, Rac = racemization):

Factor	Product			
(RNH_2)	*R*OH	*R*OEt	*R*Cl	*R*Br
$C_2H_5.CH(NH_2).CH_3$	Rac+In	..	Rac+In	Rac+In
$C_6H_{13}.CH(NH_2).CH_3$	Rac+In	Rac+In	Rac+In	Rac+In
$C_6H_5.CH(NH_2).CH_3$	Rac+In	Rac+In	Rac+In	Rac+In
$CH_3.CH(NH_2).CO_2H$	Rt	..	Rt	Rt
$CH_3.CH(NH_2).CO_2Et$	..	..	..	Rac+In
$C_6H_5.CH(NH_2).CO_2H$	Rt+Rac	..	Rt+Rac	Rt+Rac

Racemization was always especially extensive in the reactions of the phenyl compounds, just as was found in the work of 1937 on the S_N1 substitutions of halides.

This table makes it quite clear that deamination in all its forms is obeying the above-mentioned S_N1 rule. It follows that the last steps of deamination must have the form of an S_N1 process, involving a carbon-cationic intermediate, a conclusion which accommodates the frequent observation of Wagner-type rearrangements during deamination (pinacolic deamination, Demjanov reaction, etc.):

$$RNH_2 \rightarrow RNH.NO \rightarrow \underbrace{RN_2^+ \rightarrow R^+ \rightarrow RX}_{S_N1}$$

Pursuing this conclusion, it is possible, by use of the S_N1 rule, unambiguously to assign to most of the singly asymmetric amino-compounds that have been deaminated, configurations relative to those of the corresponding halogeno-compounds and alcohols. An equivalent statement is that the steric course of all those reactions which have been used either to produce the amino-compounds or to deaminate them can be considered known. For illustration, configurational correlations, thus deduced, for a few more amino-acids are as follow:

RX	*X*			
	Cl	Br	OH	NH_2
$(CH_3)_2CH.CHX.CO_2H$	..	(+)	(−)†	(−)
$(CH_3)_2CH.CH_2.CHX.CO_2H$	..	(+)	(+)	(+)‡
$C_6H_5.CH_2.CHX.CO_2H$	..	(+)	(+)	(+)
$CO_2H.CH_2.CHX.CO_2H$	(+)	(+)	(+)	(+)‡
$CO_2H.CH_2.CH_2.CHX.CO_2H$	(+)	..	(+)	(−)

† These hydroxy-acids have (+)-salts.
‡ These amino-acids have (−)-cations in aq. HCl.

Kinetic and optical details of this work will be published elsewhere.

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[1] Cowdrey, Hughes, Ingold, Masterman and Scott, *J. Chem. Soc.*, 1196, *et seq.* (1937).

[2] Winstein, *et al.*, many papers since 1939 in *J. Amer. Chem. Soc.*

[3] Davies, Thesis, London (1949).

[4] Fischer and Skita, *Z. physiol. Chem.*, **33**, 190 (1901); Fisher and Warburg, *Ber.*, **40**, 489 (1907); McKenzie and Clough, *J. Chem. Soc.*, **95**, 777 (199).

BIOLOGY OF ADULT MOSQUITOES IN EASTERN COLOMBIA

By Dr. JULIAN de ZULUETA

Instituto de Enfermedades Tropicales "Roberto Franco" (Ministerio de Higiene), Villavicencio, Colombia, S. America

THE necessity for a better understanding of the behaviour in Nature of adult mosquitoes has become of increasing importance for malaria control work, since the main stress of recent campaigns has been laid on the destruction of the adult anophelines as the best means of breaking up the malaria cycle. Unfortunately, our present knowledge of mosquito biology has been derived mainly from larval studies and observations on the aquatic habitat of mosquitoes, their terrestrial life being more difficult to approach than their aquatic phase of development. This knowledge has proved repeatedly to be inadequate in explaining the changes suffered by natural mosquito populations. Such has been our experience in Villavicencio[1], where the variations in mosquito density and the changes in species composition observed during the year could not be explained by a study of the larval life of the local mosquito species.

In a recent publication[2], we were able to demonstrate the feasibility of a close study of the life of the adult mosquito in a savanna country like the 'llanos' or plains of eastern Colombia. By means of the simple techniques evolved, it was found that the grass of the savannas is not only a diurnal resting place but also the true habitat of several mosquito species. Records were obtained of mosquito density, dispersal from breeding places and effective flight range. This last proved to be of about one mile, a considerable distance to be flown by a species in effective numbers; but we thought that the females covering such distances were not crossing the savannas attracted by an animal source of blood. It was our impression that there were, in fact, two different kinds of flight: a long flight of dispersal from the breeding areas, and another flight of much shorter range towards the source of blood.

Experiments carried out later have shown that cutting the grass, where the savanna mosquitoes rest during the day-time and over which they fly at night, produces a great drop in the number of mosquito females coming to bite. Most of the experiments were made with stable traps baited with donkeys, using two identical traps in every experiment; one was set up in the middle of a clearing and the other in the savanna at about 100 m. from the edge of the clearing. Mosquito captures were made simultaneously, the number of females caught in the uncleared area being used as control. Though the donkeys were of approximately the same size and bulk, to avoid any possible difference in their relative attractiveness, they were exchanged in every experiment.

In a series of eleven trials, 20,884 mosquito females were captured, their distribution being as follows:

	Cleared area	Control area
Anophelines	608	3,698
Culicines	6,679	9,899

The deterrent effect of getting rid of the grass was much more marked in the case of the anophelines than in the case of the culicines. The anophelines caught in the cleared area were only 14 per cent of the total number of anophelines captured, but the culicines captured in the clearing amounted to 40 per cent of the total number caught. The clearings were of circular shape, the radius varying from 10 to 50 m. In the experiments made with clearings of 50 m. radius, the anophelines entering the stable trap in the cleared area were only 8 per cent of the number captured in these experiments. In all the trials mentioned above, samples of anophelines were taken at random and identified, and it was noticed that the species composition was very much the same for both the cleared area and the control area. A total of 1,053 specimens were identified with the following results:

	Anopheline species (per cent distribution)				
	A. pessoai	*A. peryassui*	*A. parvus*	*A. darlingi*	Miscellaneous
Cleared area	72	22	2	3	1
Control	60	36	3	1	—

Two trials made with human dwellings gave similar results. Clearings of roughly 70 m. radius were made around two peasant huts in which the mosquitoes coming to bite gave an average of 39 mosquitoes per night before the destruction of the grass. No mosquitoes were captured during the two nights after the clearing was made. Though this is too small a sample from which to draw any definite conclusions, it shows nevertheless that this simple method deserves further attention from the practical point of view of malaria control. It may be added that all the experiments mentioned here were carried out in endemic areas in which *A. darlingi*, one of the chief malaria vectors of the neotropical region, was present.

The difficulty encountered by the blood-seeking females in reaching the baited trap or the human dwelling in the middle of the clearing could be interpreted either as a failure of the females to detect the bait within the cleared area, or as due to the repellent effect that a bare surface of ground may have on species living in the grass. We are inclined to believe that the first explanation is correct. In the course of our studies on mosquito density we have found that, when the continuity of the savannas is broken by an area devoid of grass, such as a road, the numbers of mosquitoes found on both sides of the clearing are practically the same. In one of our study areas a track made by motor traffic leaving a bare surface of ground 20–30 m. wide produced a clear cut across an expanse of savanna. On one side was left a wide area of savanna with numerous breeding places, on the other side no breeding places were found. The mosquitoes caught resting in the grass must have come across the track, since no suitable breeding place for savanna mosquitoes could be found in the great forest framing this side of the savanna. Using the technique already described[2] for catching resting mosquitoes, it was found that the mosquito density on the forest side was 3·6 mosquitoes per sq. m. of ground, and on the open side 2·7 mosquitoes per sq. m. This shows in the first place that 20 or 30 m. of bare ground, deterrent as they would be to blood-seeking females, have no effect on mosquitoes dispersing over the savannas; also that the density of mosquitoes tends to be higher away from the breeding places than in their vicinity, which is in agreement with our previous findings[2].

If the culicines have less difficulty in reaching the bait in a cleared area, this is probably due to their being better able to detect it and being also better fliers. In our previous studies[2] we found that the flight-range of dispersal among male anophelines was shorter than the corresponding range of the male culecines. Our present observations seem to point to a shorter range of flight in the blood-seeking anophelines than in the blood-seeking culicine females. A preliminary study on the altitude of flight among the savanna mosquitoes has shown that the culicines usually fly at a higher level than the anophelines. This may account for their greater aptitude for covering wide areas in their dispersal flight and in reaching an animal source of blood, the savanna anophelines flying too near the grass to range as freely. Data on flight-levels were obtained using muslin nets fixed to a moving vehicle, following the technique already described[2]. Two nets were used simultaneously, one fixed at 1·5 m. above the ground, just above the tops of the flowering stems of grass, the other at 4·5 m. above the ground. 3,505 specimens were captured in nine trials, the distribution being as follows:

	1·5 m. above the ground		4·5 m. above the ground	
	Males	Females	Males	Females
Anophelines	125	161	139	16
Culicines	495	607	1,858	104

Males fly higher than the females of their genus, but culicines taken as a whole tend to fly at a higher level than anophelines. It is curious to observe that such difference in distribution could be detected with a difference in altitude of only three metres. It is worth mentioning here that the vertical distribution of mosquitoes in a forest varies considerably with a small difference in altitude. The stratification of forest mosquitoes was demonstrated for the first time in Villavicencio. In the course of epidemiological studies of jungle yellow fever, Dr. Boshell was able to prove that the vector in the forest, *Hæmagogus spegazzinii*, could be found only in the upper part of the undisturbed forest[3]. Later, Dr. M. Bates proved that this zonal distribution applies not only to this species but also to many other mosquitoes living in the forest[4]. The present observations show that the stratification of flying mosquitoes is not limited to the forest but can be found also in a savanna country. A full report on the characteristics of flight of the savanna mosquitoes will be published elsewhere.

[1] Bates, M., and de Zulueta, J., *Amer. J. Trop. Med.*, **29**, 129 (1949).

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[3] Bugher, J. C., Boshell-Manrique, J., Roca-García, M., and Osorno-Mesa, E., *Amer. J. Hyg.*, **39**, 16 (1943).

[4] Bates, M., *Ecology*, **25**, 159 (1944).

THE HEALTH OF ENGLAND AND WALES

THE report of the Ministry of Health for the year ended March 31, 1949, which includes the report of the chief medical officer, Sir Wilson Jameson, for the year 1948*, shows that 1948 was remarkable in the history of health in England and Wales. Apart from the inauguration during that year of the National Health Service, the celebration of the centenary of the passing of the first Public Health Act, and the final disappearance of the Poor Law system, the total death-rate in 1948 was 10·8 and the civilian death-rate was 11·0 per thousand, both of which are the lowest figures on record. Compared with 1938, which showed the lowest standardized mortality of any year before the Second World War, the comparative mortality index at all ages showed a decline of twenty per cent. For a year of economic struggle, this is a remarkable record. Climatic influences no doubt helped, because the winter, spring and autumn were warm, and there was no epidemic of influenza; but the many facets of public health activity recorded in these reports show that, whatever the effects of the weather may be at any time, the constant, watchful efforts of many experts are always serving the public quietly, effectively and without publicity.

A valuable feature of the report of the chief medical officer is its analysis of the vital statistics for the years 1938–48. This shows that, among the principal causes of death, the most striking falls during this ten-year period occurred in the death-rates from influenza, enteritis and diarrhœa, and that there were remarkable reductions in the numbers of deaths from cerebrospinal fever, diphtheria, nervous diseases, bronchitis, pneumonia and infantile diseases, while the death-rates from measles and whooping cough fell to new low levels. Deaths from cancer, however, increased, especially among males, who suffered more from cancer of the respiratory system. The birth-rate rose; but infantile mortality fell.

The epidemiological feature in England and Wales for 1948 was the absence of epidemic influenza, and no smallpox occurred in the country. There was, however, after the repeal of the Vaccination Acts in 1946, an alarming decline in vaccinations of infants; Sir Wilson Jameson gives warning that immunity to smallpox in England and Wales is now dangerously low, and he directs attention to the section of the report which deals with this subject.

* Report of the Ministry of Health for the Year ended 31st March 1949, including the Report of the Chief Medical Officer on the State of the Public Health for the Year ended 31st December 1948. (Cmd. 7910.) Pp. xvi+374. (London: H.M. Stationery Office, 1950.) 7s. 6d. net.

The chapter dealing with immunization against diphtheria demonstrates, on the other hand, the beneficent effects of the fight against this disease. They are shown by the reduction of notifications of diphtheria and deaths from it to less than one-tenth of those recorded in the years before immunization. Reduction in the fatality-rate of scarlet fever was partly due to penicillin and the sulphonamide drugs and partly to a natural cyclic fall in the virulence of the streptococci which cause this disease. Measles was more prevalent in 1948 than in the previous year; but there were only 327 deaths from it. Trials of a prophylactic serum against measles were in progress. As many parents know, whooping cough was also prevalent in 1948; but the fatality-rate (0·51 per cent) was lower than in any other year. This disease is, however, still a prominent cause of the deaths of infants. It is especially dangerous during the first year of life and particularly during the first six months. Although special efforts are being made to find a drug to treat it, to improve methods of diagnosis and to make an effective prophylactic vaccine, the protection of infants from infection remains, at present, the best method of fighting the disease.

The incidence of cerebrospinal fever was low and sporadic; but notifications of poliomyelitis continued during the early part of 1948 at a high rate after the epidemic of 1947 and caused much anxiety. The extensive work on typhoid fever, paratyphoid fever, dysentery, enteritis and other diseases of the alimentary canal is described in some detail. That landmark in the battle of man against malaria, namely, the discovery by workers at the London School of Hygiene and Tropical Medicine of the phase of the malarial parasites which lives and multiplies in the human liver before the parasites enter the blood cells, receives the attention it deserves. Some diseases, such as anthrax and leprosy, are rare but demand a great deal of administrative labour and care. The marked fall in the incidence of syphilis recorded in 1947 continued during 1948, although it has been less marked in the large seaports, and considerable reservoirs of this disease still exist in England and Wales. The incidence of gonorrhœa has also fallen; but it is likely that many women are infected without knowing it.

The number of deaths due to cancer increased, partly because there were more people living at the ages most susceptible to this disease. It increased more in males than in females, and two-thirds of the male increase was due to cancer of the respiratory system. An interesting section of the report deals with acute rheumatism in children less than sixteen years of age and with chronic rheumatism. Other sections deal with the continuing expansion of the Public Health Laboratory Service, with outbreaks of milk-borne typhoid fever, paratyphoid fever and scarlet fever, with the Hospital Laboratory Service and the National Blood Transfusion Service, and with tuberculosis, mental disease, hospital planning and the dental services.

A survey of nutrition reports little change in the good nutritional state of school children and records satisfactory hæmoglobin levels among housewives and expectant mothers. As is well known, the treatment of flour by the 'agene' process has now ceased. The report leaves the reader in no doubt that nutrition, which is so important a means of combating disease of all kinds, is being studied in all its aspects. Not less important is the continued difficulty in providing the nursing and other staff for hospitals, and a chapter is devoted to this acute problem. The report of social survey workers describes some of the methods employed and records no real difference in the amounts of sickness recorded in 1947 and 1948. Another chapter deals with the first World Health Assembly in June 1948 and the international health work arising out of it.

In the second section of the report, the administration of the national health and welfare services are considered, and Part 2 discusses housing, local government, water, river boards and sewerage and its disposal. There are fourteen appendixes which add useful information to the great store of facts recorded in this combined report. It is, as Sir Wilson Jameson says, the work of many hands and is a monument to the effort and care expended upon the many aspects of the national health. The nation's gratitude is due to all these men and women who labour continually on its behalf. Whether their jobs are the humbler ones of the nurse or the clerk, or the more responsible ones of the expert, they constitute together a remarkable team. Sir Wilson Jameson, who retired early in 1950[1], has played a great part in building up and co-ordinating their efforts and can look back on a fine record during his term of office. He pays a fine tribute to Sir George Newman, who died in 1948[2] and who, as a predecessor in office to Sir Wilson, had guided public health activities for a quarter of a century.

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RESEARCH AND DEVELOPMENT AT BAKELITE, LTD.

On June 21, Bakelite, Ltd., opened their new research and development laboratories at Birmingham to a representative gathering of those interested in both the scientific and industrial progress of high-polymer science and technology. Although only part of the manufacturing site of this concern is located at Tyseley in Birmingham, the research and development activities of the firm are mainly centred there. The visit presented a unique opportunity for seeing how one of the old-established branches of the industry has developed on the industrial side, and how, with the advance of knowledge in the science of high polymers, that science has been integrated with technology—a first pre-requisite of a healthy and forward-looking industry.

One of the major activities concerns the thermosetting resins derived from phenols and formaldehyde and from urea and formaldehyde. In spite of the extensive use of such resins in a host of applications such as laminated materials for electrical purposes, cements and adhesives, moulding powders and oil-soluble resins for paints, the chemical process involved in the manufacture of the resin as such is to a very large extent built on empirical knowledge. That does not mean that precise methods of the control of processes and the checking of the quality of the product are not used at every stage. In fact, the visit demonstrated clearly just how much can be contributed by instrumentation to the reproducibility and efficiency of the manufacturing processes employed. The older autoclaves or 'stills', as they are called, were devoid of control devices, and the whole success of synthesis depended to a large extent on the skill of the operators. In the most up-to-date stills much of the human factor has been replaced by devices to ensure that the cycle of events in such a batchwise process is accurately reproduced time and again, so that the structure and molecular size of the resin may be kept within defined limits. There could be no better demonstration for advocates of the more extensive use and also development of instruments for application in industrial chemical processes.

The reason for the empirical development of the method of synthesis of such polymers was simply due to the fact that, forty or fifty years ago, academic interest in these matters was negligible. Indeed, it is true to say that empiricism was the only method of approach, but it has carried the industry a long way. With the considerable growth of purely scientific interest in high polymers, it was evident that the time had come for a closer integration of science and technology in the hope that science will help the technologist to achieve even greater development and exploitation of plastic materials. This is primarily the reason for the building and equipping by Bakelite, Ltd., of the first stage of research and development laboratories, to carry the above-mentioned ideas as rapidly as possible into practice.

The new building is a steel-framed construction with cavity-brick walls of a pleasing shade. Inside, the walls are plastered and furnished with cream paint. Heating is by a hot-water system supplied from an automatically controlled oil-fired boiler. The services are carried along the corridors in ducts with easy access. In the laboratories, ducts in the floors at suitable intervals provide for flexibility in the partitioning of benches and in the erection of special apparatus. Exhaustion of fume cupboards is by individual fans. Many of the furnishings—doors, library shelving, etc.—utilize resin-bonded laminated wood veneers to good effect. Laboratory benches, cupboards and wood-block flooring are constructed by the less-expensive conventional methods in hard wood. The laboratories have high ceilings, and the fixed benches are well spaced so that large-scale laboratory apparatus may be easily erected. Windows are of large area and the sills are high, so that benches with shelves can easily be fitted below the sills. Fluorescent lighting of high intensity is fixed to the ceiling, which is covered with asbestos sound-insulating material. Non-structural partitions and also metal–glass partitions make for the maximum internal flexibility of laboratory arrangement.

On the research side, a considerable volume of work is being carried out on the mechanism of the phenol–formaldehyde condensation process itself, in order to give a complete picture of the mechanism of the reaction and of the precise structure of the intermediates as well as the final products of synthesis. There was exhibited a whole range of intermediate products synthesized by rational organic methods. Similarly, methods of molecular distillation have enabled some of these intermediates to be isolated from reaction mixtures similar to those used on the large scale. Since the number of isomers present can be very large, owing to the existence of three reactive positions in the phenol molecule, infra-red and ultra-violet and spectroscopic methods are being used for structure determination. Careful studies are also being made of the kinetics of the reaction, often with the above-mentioned specially synthesized intermediates, so that the complexities of the process may be sorted out stage by stage and a closer insight gained into the various stages of this very complicated polycondensation process.

Closely associated with the fundamental research is the development side, which is fully equipped with small-scale apparatus to explore the ever-widening application of existing materials in all directions and in investigating eventually the potentialities of new materials. The facilities for evaluating the mechanical and electrical behaviour of all materials are available to the research and development departments.

There is thus added another unit to industrial research in Great Britain which will ensure that science is applied to the maximum profitable extent to an industry which might well have become traditional and wholly empirical in character, had those in charge not realized the vital necessity of bringing in the fundamental scientific approach at all stages.

SOUTH WESTERN NATURALISTS' UNION

ANNUAL CONFERENCE

THE South Western Naturalists' Union held its twenty-third annual conference at Marlborough, Wiltshire, during May 26–29, by invitation of the Marlborough College Natural History Society. Members attending the conference (about seventy) were received by the Master of Marlborough College, Mr. F. M. Heywood, in the Science Building, Marlborough College, on the evening of May 26, after which Mr. W. E. V. Young lectured on "Avebury Stone Circle". This lecture, which is to be known as the Pedler Lecture, had been financed by the British Association for the Advancement of Science from the Pedler Fund.

On the morning of May 27 a number of short talks were given by Mr. L. G. Pierson, Mr. C. R. M. Prentice, Mr. F. H. P. Barber and Mr. H. J. Killick on the birds, Lepidoptera, geology and botany of the region. On the evening of May 28, in the Memorial Hall, Marlborough College, Mr. Peter Scott, president of the Union, gave his presidential address, his subject being "Nature Reserves and their Functions, with Special Reference to the Severn Wild Fowl Trust". The address was illustrated by coloured films.

The general meeting of the Union took place on May 29, at which Mr. A. O. Rowden put forward the following resolution: "This Annual General Meeting of the South Western Naturalists' Union embracing eighteen societies domiciled in the South West of England in conference at Marlborough, this 29th day of May, 1950, views with apprehension and alarm the increasing tendency of various interests to act detrimentally to the natural and archæological amenities of Dartmoor and urges that it be designated a national park with the least possible delay". This resolution was carried, and the secretary was instructed to send copies to the Minister of Town and Country Planning, the chairman of the National Parks Committee and the clerk to the Devon County Council.

In a closing address, Sir Lewis Fermor, vice-president of the Union, stressed the thanks of the conference to the members of Marlborough College for the excellent way in which they had organised the general arrangements. At the conclusion of this highly successful conference Mr. Peter Scott was re-elected president for 1951.

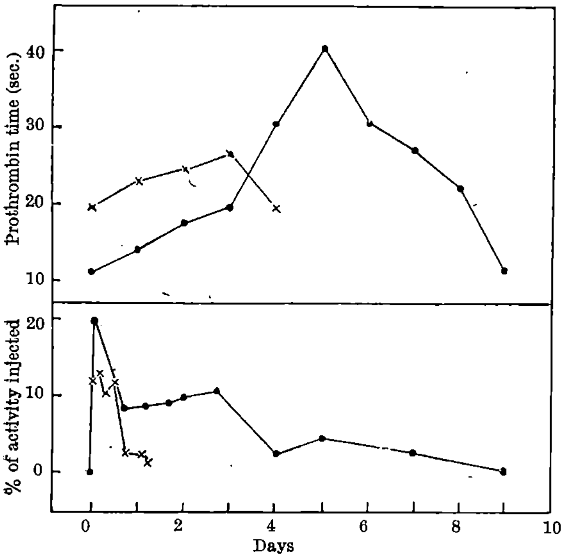
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Tracer Experiments in Mammals with Dicumarol Labelled with Carbon-14

DICUMAROL[1] is widely used clinically for the treatment of thrombosis. Since very little is known about the mechanism whereby dicumarol lowers the prothrombin-level in blood[2], it was thought that experiments with dicumarol labelled with carbon-14 might be of value. The dicumarol was prepared by adding an aqueous solution of formaldehyde containing carbon-14, obtained from the Oak Ridge National Laboratory, to a saturated aqueous solution of 4-hydroxycoumarin[3]. The 3,3′-methylene-C^{14}-*bis*(4-hydroxycoumarin) so obtained had a specific activity of 6×10^4 counts per minute per milligram, when measured with an end-window type of Geiger–Müller counter and a scale of 128.

Fourteen mice were each given 0·25 mgm. labelled dicumarol by intravenous injection. At various times after the injection, the animals were sacrificed, the tissues weighed and radioactivity determined. No significant amount of activity could be detected in the lungs, kidney and tissues in general; but large amounts of activity were found in the liver, gall bladder, fæces and urine. 80 per cent of the activity disappeared from the blood in the first hour following injection. A series of rabbits was similarly given 10 mgm. each of labelled dicumarol. A similar distribution of radioactivity was found in these animals with a rapid disappearance of dicumarol from the blood and a rapid increase of activity in the liver. By means of the isotope dilution procedure, it was shown that the activity found in the liver was essentially all unchanged dicumarol. By contrast, although a large percentage of the activity was recovered in the urine at the end of the experiment, none of the activity in the urine was due to dicumarol.



Plasma prothrombin time and radioactivity in liver of mice and rabbits after intravenous injection of dicumarol labelled with carbon-14. ×——×, mice (0·25 mgm. dicumarol); O——O, rabbits (5 mgm./kgm. dicumarol)

The rate of disappearance of dicumarol in the livers of the mice and rabbits is shown in the accompanying graph together with the changes in prothrombin time. It can be seen that, in the mice, the dicumarol remained in the liver for one day and the prothrombin-time remained high for three days, whereas in the rabbits the dicumarol remained in the liver for seven days and the prothrombin-time remained high for eight days. In further experiments, mice were injected with labelled dicumarol together with vitamin K. It was found that, for the animals receiving the vitamin, activity appeared in the liver immediately after the injection; but that in the following hours, the activity disappeared from the liver much more quickly than for the animals not receiving vitamin K.

These results demonstrate that the liver constitutes the target organ for the action of dicumarol, and they suggest that the period of time during which dicumarol remains in the liver is related to the effectiveness of this agent in interfering with the formation of prothrombin.

This work was carried out in co-operation with Mr. C. C. Lee, Mrs. R. L. Eager, Miss E. Lepp and Dr. L. W. Trevoy. We are grateful to the United States Atomic Energy Commission for supplying formaldehyde containing carbon-14, and to the National Research Council of Canada for financial assistance.

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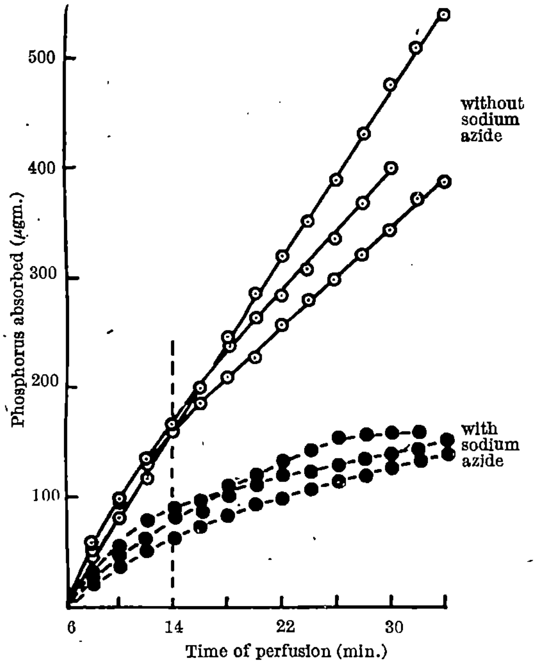
Mechanism of Absorption of Inorganic Phosphate from Blood by Tissue Cells

IN the course of a study of the phosphorus metabolism of liver, evidence was obtained suggesting that the absorption of inorganic phosphate ions from the blood is not a simple exchange of ions across the cell membrane but that it requires an energy-yielding phosphorylating mechanism. Accordingly, this hypothesis was tested by experiments in which rabbit liver left *in situ* was perfused with homologous plasma to which a small amount of carrier-free inorganic $^{32}PO_4^{3-}$ was added (2–5 μc. per litre) with or without 0·01 *M* sodium azide. The heparinized plasma, after addition of phosphorus-32 in saline, was divided into two equal volumes to one of which sodium azide was added; the two lots were used for the control and experimental perfusions, which were carried out on the liver of litter-mate animals.

The rabbits were heparinized one hour before the experiment and then were anæsthetized with nembutal and ether. The liver was prepared for the perfusion by inserting a cannula into the portal vein and tying off both the inferior vena cava above the right renal vein and the hepatic artery. A cannula was also tied into the inferior vena cava just above the diaphragm to collect the outflow from the liver. The level of the outflow was 2 cm. above the highest point of the liver, ensuring that all parts of the organ were perfused. Before the perfusion was begun, gentle pressure was applied to the liver and as much blood as possible was drawn from the outflow cannula



with a syringe to reduce the amount of blood trapped in the liver. The plasma was oxygenated before perfusion and was warmed to 38° in the reservoir.

First the blood was washed out from the liver by an initial perfusion for 6 min. at a rate of 5 ml. per min., and then the rate was slowed down to 2 ml. per min. The amounts of phosphorus-32 which disappeared from the perfusion fluid were measured at 2 min. intervals; from the known inorganic phosphorus ($^{31}P + ^{32}P$) content of the perfusion fluid, the amount of inorganic phosphorus absorbed by the liver could then be calculated.

The accompanying graph summarizes the results obtained. By the fourteenth minute of perfusion the outflow from the liver was clear plasma uncontaminated by red corpuscles, and therefore it was assumed that after the fourteenth minute all the phosphorus-32 which disappeared from the perfusion fluid was due to absorption by the liver. The graph shows that sodium azide inhibited severely the absorption of inorganic phosphate from the plasma. The average absorption of phosphorus by the liver in the control perfusions was 14 µgm. per min. and in the perfusions with azide 3·6 µgm. per min. after the fourteenth minute of perfusion. This difference amounts to a 74 per cent inhibition.

The results were subjected to an analysis of variance, for which I am indebted to Dr. W. L. M. Perry. The analysis is shown in the accompanying table. Since, however, the mean square between animals within treatment is highly significant, this term must be used as error to test the significance of the difference between treatments. The variance ratio in this case is 18·7 and with 1 : 4 degrees of freedom the probability level is 0·01–0·05. It may thus be concluded that the difference between treatments is a significant one. The specific activity of the organically bound acid-soluble phosphorus in the liver (expressed as a percentage of the specific activity of the inorganic phosphorus in the perfusion plasma), when azide-containing plasma was used for the perfusion, was only 25 per cent of that when azide was omitted from the plasma. This is an additional confirmation of the results already described.

STATISTICAL ANALYSIS OF RESULTS SHOWN IN THE GRAPH

Source of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio	*P*
Between treatments	1	8246·2264	8246·2264	285·0	<0·001
Within treatments	67	3584·5452	53·5007	1·85	0·001–0·01
Between animals	4	1763·6229	440·9057	15·25	<0·001
Within animals	63	1820·9223	28·9035		

Since azide is a known inhibitor of phosphorylation, the simplest interpretation of the results is that the transfer of inorganic phosphate across cell membranes requires phosphorylating reactions. The concentration of inorganic phosphorus in tissue cells is higher (about 10–12 mgm. per cent in the liver) than in the plasma (3–4 mgm. per cent) and therefore the transfer of inorganic phosphate from plasma to tissue cells occurs against a concentration gradient. This must require the expenditure of energy. It is thought that the phosphorylating reactions on the cell membrane rather than those within the cytoplasm are implicated in the transfer of inorganic phosphate from the extra- to the intra-cellular phase. It is known, for example, that the velocity of intracellular phosphorylating reactions within the muscle fibre is as high as in the liver, yet the permeability of muscle fibre to phosphate is much lower than that of the liver cell. This difference must be attributed to differences in properties of the respective cell membranes. Sacks[1] concluded also from *in vivo* studies of heart muscle that the transfer of phosphate across cell membranes requires a phosphorylating mechanism. Similar conclusions were reached in respect of yeast cells by Nickerson and Mullins[2] and by Spiegelman, Kamen and Sussman[3].

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Lipids of Squid Nerve

Bear, Schmitt and Young[1] have concluded that, in addition to a collagenous connective tissue investment, the giant axon of the stellar nerve of the squid, *Loligo pealii*, is also surrounded by a thin sheath rich in lipid material. This sheath, although extremely thin, is in many respects comparable to the myelin sheath of a mammalian nerve fibre. Polarization optics and X-ray diffraction studies have suggested that there is an essential unity in the ultra-structure of the lipid-containing sheath that surrounds the axon of all nerve fibres, whether vertebrate or invertebrate, myelinated or unmyelinated[2]. Little is known of the chemical nature of the lipids of this sheath in squid nerve, or of those of the axoplasm.

Table 1 shows the concentration of lipids, determined as described previously[3,4], in the entire giant fibre of the stellar nerve and in the axoplasm,

Table 1. LIPIDS OF SQUID STELLAR NERVE (mgm./100 gm. fresh tissue)

Lipid	Whole giant fibre		Axoplasm		Axon sheaths (calc.)
	Sample 1	Sample 2	Sample 1	Sample 2	
Total phospholipid	0·332	0·335	0·185	0·174	1·03
Total cholesterol	0·089	0·078	0·029	0·039	0·31
Monoaminophospholipid (phosphoglycerides)	0·282	0·238	0·146	0·160	0·74
Sphingomyelin (diaminophospholipid)	0·050	0·097	0·039	0·014	0·29

which, as Young[5] has shown, can readily be extruded. Since we were concerned with obtaining axoplasm not contaminated with sheath fragments, the technique of Steinbach[6] was employed. Each set of analyses was done on tissue from eleven to fifteen squids.

The concentration of total phospholipid, cholesterol, monoaminophospholipid and sphingomyelin was greater in the whole fibre than in the axoplasm. There can be little doubt that these lipids are concentrated in the nerve sheaths. The figures in the last column of Table 1 were calculated from the mean concentration of lipids in both the whole fibre and the axoplasm on the assumption that the axoplasm represents 82 per cent of the wet weight of the fibre[7]. The concentration of the lipids in the lipid-containing sheath itself would be many times the values calculated for the axon sheaths, since the axon sheaths are comprised chiefly of connective tissue, the lipid-containing sheath representing only a small fraction of the total (see ref. 1, Fig. 2). On the assumption that this connective tissue contains little lipid, the figures calculated for the axon sheaths give an indication of the relative amounts of lipid in the lipid-containing sheath. The figures for total phospholipid, total cholesterol and monoaminophospholipid are reasonably accurate; but the accuracy of the figure for the sphingomyelin, calculated from figures that are themselves by difference, is considerably less.

Table 2. DISTRIBUTION OF LIPIDS RELATIVE TO TOTAL PHOSPHOLIPID

	Sheaths of squid giant fibre (calc.)	Pallial nerve of squid	Whole giant fibre of squid stellar nerve	Sciatic nerve of cat
Total phospholipid	100	100	100	100
Total cholesterol	30	32	25	53
Monoaminophospholipid (phosphoglycerides)	72	71	78	61
Sphingomyelin (diaminophospholipid)	28	29	22	39
Cerebroside	—	0	0	40
Lecithin	—	43	—	12
Kephalin	—	29	—	49

Insufficient material precluded a determination of lecithin and kephalin in the giant nerve fibre and rendered a zero reading for cerebroside equivocal. However, Table 2 shows that there is also no cerebroside in the pallial or mantle connective nerve. Since the pallial nerve, the main connexion between the group of ganglia of the central nervous system and the stellate ganglion[5,8], provided more tissue, greater confidence can be placed in these analyses.

Table 2 shows the distribution of lipids relative to total phospholipid, which was arbitrarily represented as 100. The relative distribution of the lipids in the lipid-containing sheath was not greatly different from that of the pallial nerve or, incidentally, from that of the whole giant fibre of the stellar nerve. The table also gives relative figures for the sciatic nerve of the cat[4], a mammalian nerve the lipids of which are largely in the myelin sheath. Cephalopod tissue differed from the mammalian in that it contained no cerebroside, thus confirming an earlier observation of Lanfranchi[9] for the nervous system of the octopus. There was also relatively less total cholesterol and sphingomyelin and relatively more monoaminophospholipid in the lipid-containing sheath of squid nerve. For the pallial nerve a greater percentage of this monoaminophospholipid was lecithin and less kephalin.

The results reported here are in every way consistent with the view that the giant axon of the stellar nerve of the squid possesses a lipid-containing sheath. However, despite an essential unity in ultra-structure, the lipid components of this sheath would appear to differ in a number of respects from those of mammalian nerve.

This work was financed by a grant from the National Research Council of Canada and the material was collected by one of us (J. D. McC.) during the tenure of a National Research Council Summer Scholarship at the Marine Biological Laboratory, Woods Hole. Thanks are due to Dr. H. B. Steinbach for advice with the dissection.

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Composition of Human Sero-Mucoprotein

RESEARCHES into the properties of the mucoprotein component of human and animal plasma have been carried out by a number of workers, among the more recent investigations being those of Rimington[1], Hewitt[2], Winzler *et al.*[3,4] and Werner and Odin[5].

The special features of this fraction, distinguishing it from the other plasma proteins, are its non-coagulability by heat, its great solubility in water and ammonium sulphate solution, and its solubility in sulphosalicylic and perchloric acids. Each of these characteristics has given rise to different methods of isolation yielding products which have different values for total nitrogen and for the ratio, hexose/total nitrogen. It must be concluded, therefore, that each method gives a material either in a different state of heterogeneity or possibly in a different stage of degradation of an indigenous protein.

The fraction responsible for the serum 'filtrate wave' on the polarograph described by Brdicka[6] in his examination of normal and cancerous sera is derived by sulphosalicylic acid deproteinization and, therefore, seems to fall into the category of mucoprotein as defined above. In connexion with work on this and other sero-diagnostic techniques for cancer, we have isolated specimens of the mucoprotein from human serum, using both the sulphosalicylic and perchloric acid methods of isolation. The nitrogen and tyrosine contents were, respectively, 7·09 and 3·05 gm. per cent dried material, which are close to those given by Winzler *et al.*[3].

By chromatographic analysis of hydrolysates on filter paper, we have distinguished the following amino-acid components: phenylalanine, leucine and *iso*leucine, tyrosine, methionine, valine, proline, alanine, threonine, serine, glycine, aspartic acid, glutamic acid, histidine, lysine and arginine. Cyst(e)ine has been identified polarographically on the unhydrolysed material, while tryptophane and tyrosine have been distinguished by a study of the ultra-violet absorption curve. The qualitative analysis for all these amino-acids has not previously been reported, although Winzler gave the following values: cystine 0·5, tyrosine 4·2, methionine 2·1, tryptophane 1·8 gm. per cent dry weight.

The sugar components of ox sero-mucoid have been reported by Werner and Odin[5] as mannose, galactose and glucosamine. Using a similar pyridine/amyl alcohol/water mixture as solvent, we have separated and identified in the human sero-mucoid these same constituents.

After developing the colour for the amino-sugars with the Morgan and Elson reagent[7], a spot produced by a reactant with slow mobility was observed. We believe this may be attributed to a compound formed by the interaction of hexoses with lysine or other amino-acids which has been described by Horowitz *et al.*[8].

Work on the quantitative analysis of human sero-mucoprotein derived from human normal and cancer serum is proceeding for the amino-acid and sugar components.

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A Sulphated Mucopolysaccharide in Human Dentine

THE presence of a polysaccharide resembling chondroitin sulphate in human dentine has already been described[1]. An undegraded polysaccharide with a low ash content has now been separated from human dentine. Dry human dentine (1 gm.) is reduced to a 180/200 mesh powder, then dialysed in 1 litre of 0·05 *N* hydrochloric acid for about ten days with frequent changes, at room temperature; this reduces the calcium content. When the outer fluid shows only a trace of calcium, *p*H of the suspension is brought to 6·0 and it is then heated to 80° for 20 min., as suggested by Partridge for cartilage[2]. The mass is then shaken with 10 per cent calcium chloride[3] and again dialysed against distilled water. The bulk is then made up to about two litres with distilled water, and *p*H adjusted again to 6·0. Separation of protein is effected by shaking with 80 ml. chloroform and 32 ml. amyl alcohol to each litre. The bulk is then reduced by boiling at about 42° under reduced pressure; drying is completed over phosphorus pentoxide. The yield from 1 gm. dry dentine was 26·4 mgm. polysaccharide.

The polysaccharide has been hydrolysed: (*a*) by a dried preparation of a Gram-negative bacillus isolated from dental caries; (*b*) by a living culture of *Penicillium spinulosum* at room temperature (kindly identified by Mr. G. Smith, of the London School of Hygiene); (*c*) by 2*N* hydrochloric acid in 10 hr. at 100°. Before hydrolysis neither free sulphate nor hexosamine can be detected, but both are found after hydrolysis by any of these three agents. Difficulty was met both in lowering the ash content and in separating polysaccharide from protein without degrading the polysaccharide. Meyer *et al.*[4] describe a method of preparation of chondroitin sulphate from cartilage in which shaking with a chloroform–amyl alcohol mixture is repeated twenty-four times. In the present work, despite prolonged and repeated shakings, all polysaccharide separated from dentine gave a trace of colour when tested by the Sakaguchi reaction.

	Chondroitin sulphate (theoretical, refs. 3, 4)	Found for sulphated mucopolysaccharide from human dentine
C	30·7 per cent	42·0 per cent
H	4·8 ,,	6·7 ,,
N	2·6 ,,	5·4 ,,
S	5·9 ,,	4·6 ,,
Acetyl	8·1 ,,	8·1 ,,
OCH_3	0 ,,	0 ,,
Hexosamine	33·5 ,,	26·3 ,,
Hexuronic acid	36·5 ,,	28·0 ,,
Ash	0 ,,	1·5 ,,

I am indebted to the Medical Research Council for financial assistance, and to my colleagues at this Hospital.

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Inorganic Pyrophosphate in Insect Tissue

As reported earlier by Heller[1], the fat bodies of the male of the butterflies *Deilephila euphorbiæ* contain a substantial quantity, some 110 mgm. per cent, of phosphorus which yields inorganic orthophosphate on 7 minutes hydrolysis in *N* hydrochloric acid at 100° C. This readily hydrolysable phosphorus fraction, at first thought to consist chiefly of adenosinetriphosphate, was recently subjected by us to purification by the method of Jones[2] (as modified by Lehninger and Smith[3]), which consists in precipitation of inorganic pyrophosphate as manganese salt but leaves adenosinetriphosphate in solution.

In this way it was possible to show that only a part of the easily hydrolysable phosphorus present in the experimental material is adenosinetriphosphate, whereas as much as 60 per cent (in some preparations up to 80 per cent) of the 7-minutes hydrolysable phosphorus was identified as inorganic pyrophosphate. This was found to be localized mainly in the ductus ejaculatorius simplex (2,200 mgm. per cent phosphorus). It was converted into silver pyrophosphate which had a content of 71·4 per cent silver, as against 71·2 per cent required theoretically. The crude manganese precipitate was also found to contain a very small admixture of metaphosphate, and a small quantity of yet another metaphosphate compound was detected in the supernatant solution. The whole of the metaphosphate could be precipitated by the procedure used by Mann[4] for metaphosphate from moulds (precipitation with sodium hydroxide at *p*H 5·2 from a trichloroacetic–ethanol extract).

Hitherto the evidence for the occurrence of inorganic pyrophosphate in Nature was confined mainly to moulds[4] and yeast[5]. Our results, however, provide a proof of the occurrence of inorganic pyrophosphate in an animal tissue. They lend, at the same time, new significance to observations of other authors[6,7] concerning the role of inorganic pyrophosphate in the intermediary metabolism of cells.

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A Simple Gasometric Method for the Analysis of the Fermentation-inhibiting Properties of Antimicrobic Agents

RECENTLY, Heim and Poe in the United States introduced a very convenient method for evaluating antimicrobial properties of organic compounds[1]. They used, for example, *Aerobacter aerogenes* and *Saccharomyces cerevisiæ* as test strains, and based the estimation on the volume of gas found on incubation in lactose and glucose broth respectively for 72 hr. or less at 37° C. We have applied the same principle as a convenient method for estimating fermentation-inhibiting properties.

As an inoculum a 10 per cent suspension of fresh baker's yeast (*Saccharomyces cerevisiæ*) is used, in a concentration of 1 vol. per cent. This method of inoculation—which can be carried out in any laboratory, not necessarily specializing in microbiology—is prescribed by the Dutch Food Law in a test for establishing qualitatively the presence or absence of preservatives in fruit juices[2]. Counts on 'Difco' malt agar at 25° C. showed that such an inoculation corresponds to about 10^7 yeast organisms per ml. Variations due to different inoculations or to differences in the age of the baker's yeast used do not impair the consistency of the results obtained, since blanks are always carried out to eliminate these fluctuations.

Commercially bottled depectinized filtered apple juice ($n^{20}_D \sim 1\cdot350$, corresponding to about 12 per cent of sugars; *p*H about 3·5) was chosen as the medium. This juice is a satisfactory source of nutrients for yeasts[3] and possesses a fair buffer capacity. A further merit of this medium is that it is generally commercially available in Holland as a sterile liquid, free from preservatives; the latter are forbidden by the Food Law. Hence from this point of view, too, the method is generally applicable in purely chemical laboratories.

Incubation is carried out in sterilized ($\frac{1}{2}$ hr. at 170° C.) Einhorn tubes for 12–48 hr. at 25° C. The volume of gas formed is not recalculated to standard pressure. The inaccuracy involved by omitting this recalculation is about 1·2 per cent. This is significantly less than the precision of the technique, which in the 'best' replicates did not surpass 4·3 per cent.

The method has been used successfully in our laboratory for more than a year in testing preservatives and in detecting the same. It should be noted, however, that this method of detection and evaluation is only applicable to those preservatives which in the concentrations usually found in practice exert a powerful specific inhibition of yeast fermentation.

There exist some agents, for example, sulphonamides and antibiotics, which selectively inhibit the multiplication of micro-organisms. Such agents as a rule only become active after some divisions have occurred[4]. According to our measurements, this means that in the present test their action begins after a period of the order of 10 hr., that is, when fermentation as a rule is greatly advanced. Hence such agents do not greatly influence the results of the present fermentation test. To detect and evaluate compounds acting in the latter way a low inoculation (of the order of 10^4/ml.) must be used. The test then takes 48–96 hr. Work along these lines is in progress.

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Penetration of Benzpyrene through the Intact Skin of New-Born Mice

WHEN the skin of the mouse is painted with a benzene or an acetone solution of a carcinogenic hydrocarbon, it is found afterwards that a part of the carcinogen remains in the keratinized layer of the epidermis, while some of the carcinogen (fluorescent material) immediately enters the pilo-sebaceous apparatus and is found dissolved in the lipid droplets within the gland cells. Several authors have suggested that the pilo-sebaceous apparatus plays an important part in the genesis of skin cancer by providing channels through which the carcinogen may penetrate the epidermis[1]. It was thought that a study of carcinogenic action on new-born mice[2,3,4] would throw light on this problem, for it has been observed that new-born mice (2–10 hr. after birth) are refractory to a single application of methylcholanthrene. The absence of sebaceous glands, the lack of a way of entering via the hair follicles and also the thicker epidermis of new-born mice, confirmed by histological examination, would explain ineffectiveness of methylcholanthrene for tumour formation. The literature does not seem to contain any convincing evidence that the carcinogen is absorbed by the epidermal epidermis without mediation of the follicular pathways.

We have investigated, with the fluorescence microscope technique, the penetration of the carcinogen into the skin of new-born mice. In this investigation we have made use of some new solvents (mediators) for the carcinogenic hydrocarbons, characterized by their water- and fat-solubility ('Carbowaxes', certain polyethylene glycols, compounds in a non-aqueous state[5-7]), or their ability to dissolve both water- and fat-soluble substances (aqueous solutions of certain association colloids[8-12]).

Material and technique. The mice examined were of the mixed strain we have employed in our studies during recent years. The ages of the animals varied: 2, 5, 10, 15, 30 and 60 min., and from 1 to 24 hr. Adult mice were also examined, and the total number of animals used was about two hundred. A large area of the back of a mouse was painted and the animal killed 2–20 min. later, or after 24–48 hr. Skin sections, 10 microns in thickness—both with and without preceding fixation in a 10 per cent neutral formalin solution—were cut on a freezing microtome and examined immediately and again after twenty-four hours with a fluorescence microscope (Reichert Lux *UV* with a 'Philora'-lamp *HPW* 125 W.). The concentration of the carcinogen, 3 : 4-benzpyrene, in the various solutions was 0·5 per cent.

Observations. When the water- and fat-soluble 'Carbowax 1500' was used as mediator and solvent for benzpyrene, a blue to blue-violet fluorescence was encountered immediately after application, not only in the keratinized layers but also in all layers of the epidermis; both in the intercellular spaces and intracytoplasmic spaces in the cells (the nuclei, however, were devoid of fluorescent material), as well as in the subcutaneous fatty tissue. Although the new-born mice (2–60 min. after birth) had no open communications with the epidermal surface, benzpyrene (or its fluorescent metabolites) had entered the epidermis. Some of the mice, however, had a few sebaceous glands; but they were without any connexion with the skin surface. When the new-born mice were painted immediately after birth and killed twenty-four hours later, fluorescent material was observed to some extent in the keratinized part of the epidermis; but almost none was left in the epidermis itself, or in the subcutaneous fat, and none at all in the few newly developed sebaceous glands. In adult mice, that is, mice with a hair coat, the fluorescent material is, in general, observed in all the cutaneous elements mentioned twenty-four hours after a single application.

When the skin of new-born mice was painted with benzpyrene dissolved in other solvents, for example, acetone, fluorescent material was also found in the same elements of the skin.

The observations reported here indicate that benzpyrene can penetrate directly into the living epidermis by ways other than the pilo-sebaceous apparatus. On the other hand, however, it is quite clear that the carcinogens accumulate in the sebaceous glands and in the keratinized elements if they exist, and the route of maximum penetration is through the cutaneous openings. The epidermis will then, in the case of mice with developed hair coat, be continuously supplied with carcinogen from these 'stores'.

The present work is part of a systematic investigation on the significance of the nature of the solvent for the carcinogenic hydrocarbons in chemical carcinogenesis in general.

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Oriented Overgrowth of Alkali Halides on Metals

IN a recent discussion of oriented overgrowth, Sir George Thomson[1] has pointed out that near equality of spacing of atoms in the two crystals in contact is not always a necessary condition for such growth to occur. It appeared that the presence of cracks or steps in the mother crystal plays an important part. Some evidence for this belief was the observation of Andrade and Martindale[2] that small crystals of gold or silver grown on glass and diamonds show a preference for nucleation on cracks or scratches on the surface.

Although many examples of oriented overgrowth are known, there are very few cases of growth of ionic crystals from solution on metallic surfaces. Royer[3] concluded that such growth is unlikely between substances of different binding. Sloat and Menzies[4] observed oriented growth of ammonium bromide and caesium chloride on a silver crystal the lattice constants of which differed from that of silver by less than 1 per cent. These observations led to the view that oriented overgrowth of ionic crystals from solution on metals would occur only in special circumstances and only when the lattice fit was particularly close.

I have made several new observations of epitaxy of alkali halides crystallized from solution on metallic surfaces which clearly show that this view must be modified. The salts were crystallized from an ethyl alcohol – water solution. The effects were observed under an optical microscope. Strong orienting effects have been found in the following cases:

(1) Sodium chloride on the (100) and (111) planes of silver (oriented thin films), on the (111) plane of copper, and on polycrystalline antimony, bismuth, zinc and silver.

(2) On the (111) plane of a cleaved crystal of bismuth, sodium, potassium and rubidium chlorides were all oriented, and the orientation appeared to be the

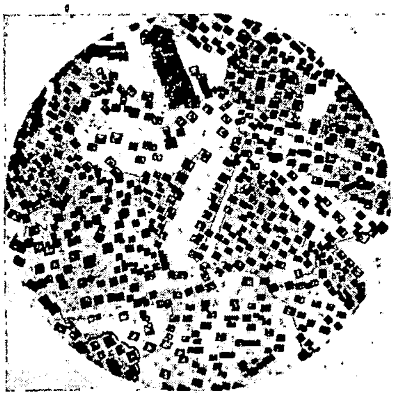

Fig. 1

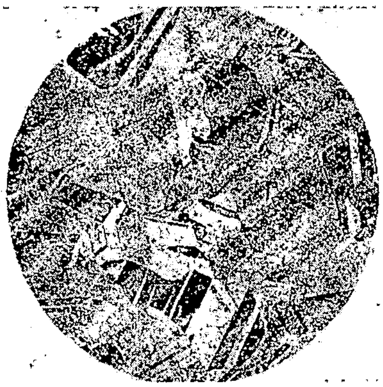

Fig. 2

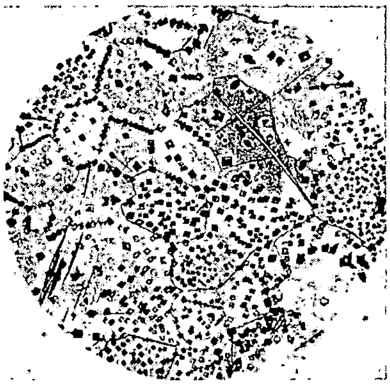

Fig. 3

Fig. 1. Oriented overgrowth of sodium chloride on polycrystalline silver after polishing and etching. Note the variation of density of crystallization from one grain to another. × 75

Fig. 2. Structure of silver sheet revealed by preferential crystallization of sodium chloride on polished polycrystalline silver (unetched). × 75

Fig. 3. Oriented overgrowth of sodium chloride on polycrystalline zinc. Note preference of grain boundaries in some cases as sites for crystallization. × 37

same in all cases. On cleaved antimony, only sodium chloride was oriented. The cleaved surface of bismuth or antimony is covered with steps which give the appearance of straight lines intersecting at about 60°.

The alkali chloride crystals assumed the form of equilateral triangles or hexagons, and in every case the straight edges were parallel to the cleavage lines of the bismuth or antimony surface. This lends support to Thomson's view of the mechanism of orientation, since important lines of atoms in the crystals did coincide with the directions of the steps in the surface. However, the fact that only sodium chloride was oriented by antimony indicates that lattice spacings also must be considered. Polishing the cleavage planes and etching in perchloric acid gave surfaces which oriented the halide crystals in the same manner as had the original surface.

(3) With polycrystalline iron–silicon (3 per cent silicon), on only one grain out of about forty examined was epitaxy observed, in this case only with caesium chloride. X-ray diffraction revealed this grain to be oriented with its (100) plane parallel to the surface. Attempts to observe epitaxy on a (110) face of such a crystal all failed.

On most other polycrystalline materials some form of epitaxy occurred on almost every grain. A typical example is given in Fig. 1, which shows this effect with sodium chloride on polycrystalline silver. The distribution of crystallization was uniform over each grain, or if it was twinned, over those parts of the grain with the same orientation. The density of crystallization varied from grain to grain depending upon their orientations. The latter result was used in one instance to reveal the grain structure of polycrystalline silver (Fig. 2). The grain structure was brought out by producing very small ($\sim 1\ \mu$ diameter) crystals of sodium chloride using a strongly alcoholic solution and rapid drying.

In general, no preference for grain boundaries as sites for nucleation of crystallization was observed; however, with sodium chloride on zinc such a preference was indicated (Fig. 3). From the results of Andrade and Martindale it might have been expected that the grain boundaries on an etched surface would be likely sites for nucleation.

It is clear that closeness of fit cannot be regarded as a strict criterion for the occurrence of epitaxy for the systems described here; for, first of all, on cleaved bismuth, salts with lattice constants differing by 15 per cent (sodium and rubidium chlorides) were oriented in the same way. In addition, since some form of epitaxy was noted for almost all grain orientations on polycrystalline metals (except iron), it appears unlikely that close fits could be achieved for all of them. Finally, sodium chloride was oriented in the same way on the (111) planes of both silver and copper, the lattice constants of which differ by about 10 per cent.

That the orientation of the alkali halide crystals was determined in the embryonic stages of growth is suggested by the observation that the crystals often grew across grain boundaries and over surfaces of different orientation without modification.

This work was carried out at the Brookhaven National Laboratory under the auspices of the Atomic Energy Commission.

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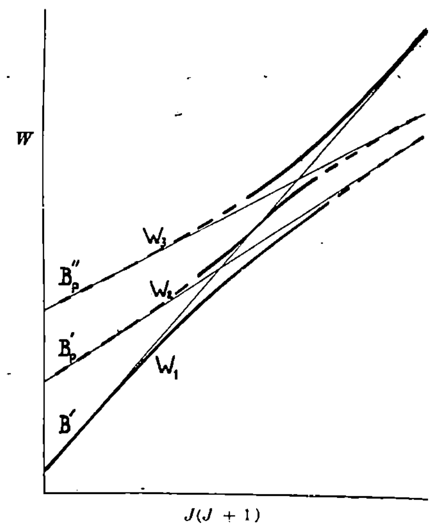
An Infra-Red Band-System of Calcium Oxide

The introduction of calcium salts into flames or arcs gives, in the presence of oxygen, a very complicated band-spectrum from the near ultra-violet up to the infra-red. The spectrum contains several systems, most of which can be attributed to CaO. The analyses hitherto performed—both vibrational and rotational—do not, however, appear entirely trustworthy. Brodersen[1,2] has given, in two papers, rotational analyses of some infra-red and blue bands. He has also tried unconvincingly to arrange several band-systems into an energy-level scheme. This scheme seems to us to be very artificial.

We therefore considered it desirable to carry out new rotational analyses, in the first place of the infra-red bands. As source we used an arc between pure calcium electrodes burning in air. In the region 7000–9000 A. the spectrograms were taken in the



first order of a 21-ft. Wood concave grating having a dispersion of about 1·1 A./mm. Between 9000 and 10,500 A., a plane grating with dispersion 4·5 A./mm. in the second order was used.

In the low-dispersion plates, five clear sequences appear at 7308, 7715, 8153, 8652 and 9229 A. These bands comprise a $^1\Sigma-{}^1\Sigma$ band-system with the 0,0 band at 8652 A. Sixteen bands have been analysed, namely, the 6,3, 5,2, 5,3, 4,1, 4,2, 3,0, 3,1, 3,2, 2,0, 2,1, 2,3, 1,0, 1,1, 1,2, 0,0 and 0,1 bands. The rotational constants derived in the present work are as follows:

$B'_6 = 0{\cdot}396_5$
$B'_5 = 0{\cdot}398_6$
$B'_4 = 0{\cdot}400_8$
$B'_3 = 0{\cdot}401_6$
$B'_2 = 0{\cdot}402_4$
$B'_1 = 0{\cdot}403_0$
$B'_0 = 0{\cdot}405_6$
$r_e = 1{\cdot}906 \times 10^{-8}$ cm.
$D' = 0{\cdot}55 \times 10^{-6}$
$\omega'_e \sim 715$

$B''_3 = 0{\cdot}4328$
$B''_2 = 0{\cdot}4362$
$B''_1 = 0{\cdot}4394$
$B''_0 = 0{\cdot}4428_0$
$r''_e = 1{\cdot}822 \times 10^{-8}$
$D'' = 0{\cdot}66 \times 10^{-6}$
$\omega''_e = 732{\cdot}1_1$
$x_e''\omega_e = 4{\cdot}8_1$

In the upper vibrational levels the bands are strongly perturbed. The perturbations displace the positions of the bands in the sequences and make the analysis very complicated in some parts. In the 0,0 band a very curious perturbation appears. For some J-values the upper level $v' = 0$ is perturbed by two states. The accompanying graph shows the energy-levels $BJ(J+1)$ plotted against $J(J+1)$ of the three interacting terms. The energy curves are marked W_1, W_2 and W_3. In the perturbed region, three R- and three P-lines are found. As we know that the centre of gravity energy line is unperturbed, we obtain by calculation the following equation for the relation between the B-values:

$$\frac{B' + B'_p + B''_p}{3} - B'' = \frac{1}{12J} \sum_{1}^{3} \Big[P_v(J+1) - R_v(J-1) - P_v(J) + R_v(J-2)\Big],$$

where the suffixes 1, 2 and 3 indicate lines from the three interacting energy-levels W_1, W_2 and W_3. For $J = 54$, 55, 56 and 57, the value of $(B_p + B''_p)$ is found to be 0·7102, 0·7099, 0·7100 and 0·7103 respectively.

The B'_v-values vary rather irregularly. This is due to the strong perturbations. We would stress that for strongly perturbed levels it is almost meaningless to speak of a fixed B-value, as it varies from one rotational level to the next. In most cases the B-value given is that nearest to the 'unperturbed' one.

A lot of bands are situated between 9500 and 10,500 A. They form other band-systems belonging to CaO. Meggers[3] has given some measurements of the band-heads.

A more detailed paper will appear in *Arkiv för Fysik.*

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Electric Strength of Aluminium Oxide Films

FRÖHLICH'S theory of dielectrics predicts an increase in the electric strength as the thickness of the dielectric specimen approaches the electronic mean free path. This prediction has been verified experimentally for certain crystalline materials, such as mica and the alkali halides. Recent work with thin films of amorphous aluminium oxide shows that its electric strength also increases if the film thickness is less than 10^{-5} cm. The oxide was formed by 'anodic oxidation' of aluminium which had been evaporated in a vacuum on a glass optical flat, the film thickness being measured by means of multiple reflexion fringes. The potential difference across the film was applied through small steel bearings. Some of the results obtained at 290° K. in a vacuum of 10^{-5} mm. of mercury are as follow:

Film thickness (A.)	134	195	580	830	1540
Electric strength (volts/cm. × 10⁶)	11·0	9·9	7·3	6·3	5·2

A full account of the investigations is being published elsewhere.

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Oscillator Strength of the Na_2 $^1\Sigma-{}^1\Sigma$ Transition

WHILE the oscillator strengths (or f-values) of various molecular electronic transitions are urgently required by astrophysicists, very few experimental or theoretical results are available. I have recently carried out a calculation for the f-value of the $^1\Sigma-{}^1\Sigma$ transition of the sodium molecule based on the simple hydrogen-ion model. In this calculation the wave functions of the two states were represented by a simple linear combination of the appropriate atomic wave functions (these being taken as Slater-type functions with effective nuclear charge $2{\cdot}2e$ and $n^* = 3$). Taking the internuclear distance as $3{\cdot}36\,a_0$ (a_0 is the radius of first Bohr orbit) and the wave-length of the electronic transition as 6812 A., the f-value was found to be 0·26, corresponding to a mean life-time of $1{\cdot}7 \times 10^{-8}$ sec. No experimental measurement of this life-time has yet been made, but the value would not be expected to be widely different from the value for the blue-green system ($^1\Sigma - {}^1\Pi$), which has approximately the same intensity. The life-time of this system was measured by Hupfeld[1] and found to be $1{\cdot}0 \times 10^{-8}$ sec., which is of the same order as the theoretical result. Further results based on the hydrogen-ion and the hydrogen-molecule approximations will be reported in greater detail at a later date.

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Relative Diameters of Galaxies

IN their communication on galactic noise and the rotation of the galaxy[1], Bolton and Westfold remark, on the basis of some early measures from the Mt. Wilson Observatory[2], that "the size of the external galaxies increases steadily with increasing spiral structure", and this result is used to support the surmise that our own large galaxy presumably has spiral structure. There are other strong evidences of the spiral structure of our galactic system, and therefore the revision of the results underlying the statement quoted above is of no consequence to the subject-matter of the communication by Bolton and Westfold.

The general inspection, and later the visual measurement of the ordinary photographs of external galaxies, indicated to both the Harvard and Mt. Wilson observers many years ago that the spheroidal and elliptical systems were distinctly smaller than the spirals. The later Harvard work with appropriately exposed small-scale plates showed, however, that there is no essential difference in the over-all size of spheroidal and spiral galaxies[3]. Afterwards, the microdensitometer was used to measure the photographic images, the equality of dimensions was confirmed, and both the spheroidal and the spiral systems were found to be much larger than previously supposed[4]. For example, the Mt. Wilson estimates gave the mean linear diameter of the spheroidal systems $E0$, $E1$, . . . $E7$ as 0·36, 0·43, . . . 1·13 kiloparsecs, whereas comparable Harvard measures on small-scale plates gave the mean values of $E0$–$E7$ as 3·7 kps.

When the Harvard plates of the Virgo Cloud of galaxies were measured with the microdensitometer, the following results were obtained, with the diameters in kiloparsecs.

Class	Median	Mean	Number
*E*0–*E*7	4·6	4·9 ± 0·4	13
*S*0, *Sa*, *Sb*	4·2	4·4 ± 0·2	30
Sc	4·3	4·7 ± 0·3	69

Another determination with allowance for the possible selection on the basis of apparent magnitude gave 4·05 and 4·57 kiloparsecs for the mean diameters for spheroidal and spirals, respectively.

The spiral structure ordinarily photographed in external galaxies is rarely detected at more than half a radius from the nucleus. The arms are, in a sense, superficial, involving in most instances less than a quarter of the mass and light of the galaxy, and in my view they indicate an early stage in the development of a galactic system[4,5].

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New General Methods for the Synthesis of Fluoroiodides and Fluoroacids

THE unusual properties associated with the fluorocarbons are now well defined, and current interest lies in the synthesis of compounds which contain fluorocarbon groups such as perfluoroalkyl groups. For such syntheses, compounds of the type RX are required, where R is a fluoroalkyl group (CF_3, CF_2Cl, C_2F_5, etc.) and X is a reactive group. The fluoroacids (X = COOH) are examples of such compounds, but lead in general to compounds of the general formula RCH_2Y, in which a —CH_2— group has been introduced. The fluoroiodides, RI, have received attention recently, and it is now known that they readily yield perfluoroalkyl radicals which can be used for synthetic work. In particular, it has been reported that trifluoroiodomethane will bring about an addition polymerization with ethylene[1] and with acetylene[2] to give compounds of the type $CF_3[CH_2CH_2]_nI$ and $CF_3[CH{=}CH]_nI$.

The method used for the synthesis of trifluoroiodomethane until recently was the fluorination of carbon tetraiodide with iodine pentafluoride[3]. A method has now been evolved for the synthesis of this fluoroiodide in good yield from the commercially available trifluoroacetic acid. When salts of this acid—lead, silver and even sodium or potassium—are thoroughly mixed with iodine and heated, simultaneous decarboxylation and iodination occur, and the gaseous products are carbon dioxide and trifluoroiodomethane. The fluoroiodide, easily purified by fractionation, can thus be prepared without recourse to elementary fluorine. This reaction is general for the synthesis of fluoroiodides. Dicarboxylic fluoroacids yield di-iodides, and fluoroiodides such as CF_2ClI, $CFCl_2I$, CHF_2I, CF_2I_2 and $I(CF_2)_{2-4}I$ are now easily prepared. Fluoroiodides derived from other fluorohaloacids are being investigated. By treatment with iodine pentafluoride as described previously[4], the compounds $I(CF_2)_{2-4}I$ can be converted into $CF_3(CF_2)_{1-3}I$.

Now, it has been shown that a fluoroiodide such as trifluoroiodomethane will undergo an addition-polymerization with tetrafluoroethylene to give a polymer $CF_3[CF_2CF_2]_nI$, from which the compounds with n = 1–10 may be isolated[1]. From the fluoroiodides, RI, mentioned above, it will be possible to synthesize the compounds $R[CF_2CF_2]_nI$, where n = 1–10. The fluoroiodides can be converted into the corresponding carboxylic acids by the general procedure of reaction with acetylene and isolation of the first member of the series (which constitutes *c.* 80 per cent of the product), followed by permanganate oxidation; the double bond on a carbon atom adjacent to a fluoro group is susceptible to oxidation, and $CF_3CH{=}CHI$, for example, readily yields trifluoroacetic acid.

The synthesis of the new perfluoro acid pentafluoropropionic acid, achieved in collaboration with Mr. K. Leedham, also illustrates this reaction. Pentafluoroiodoethane (prepared from tetrafluoroethylene[4]) and acetylene yield 1 : 1 : 1 : 2 : 2 pentafluoro 4-iodobutene (b.p. 84·4°), which with alkaline permanganate affords pentafluoropropionic acid (b.p. c. 95°), characterized as its amide (m.p. 95–95·5°). Like trifluoroacetic acid, pentafluoropropionic acid is a strong acid which fumes in air and which has a high density and low refractive index. Similarly, heptafluorobutyric acid, described recently[5], has been synthesized from heptafluoroiodopropane.

Thus, two general synthetic methods are now available; the first, to prepare fluoroiodides from the corresponding fluoroacids; the second, to convert fluoroiodides, prepared by various routes, into the corresponding fluoroacids. The properties of some of the compounds mentioned above are being studied and will be described in more detail elsewhere.

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Electron Affinities of Some Aromatic Molecules

EVIDENCE[1] is available to indicate that in the reduction of some aromatic molecules at the dropping mercury electrode one electron is added on to the neutral molecule.

From a knowledge of the absolute potential, E, at which this reduction occurs, of the photo-electric work function, χ, of mercury and of the solvation energy, S, of the ion formed, it is possible to calculate simply the electron affinity, A, of the neutral molecule.

To do this, consider the process of reduction as taking place in three stages :

$$(\mathrm{Hg})_{\mathrm{drop}} \rightarrow (\mathrm{Hg})^{+}_{\mathrm{drop}} + e \qquad (1)$$

$$R + e \rightarrow R^{-} \qquad (2)$$

$$R^{-} + \mathrm{aq.} \rightarrow R^{-}(\mathrm{aq.}) \qquad (3)$$

where R is the neutral molecule.

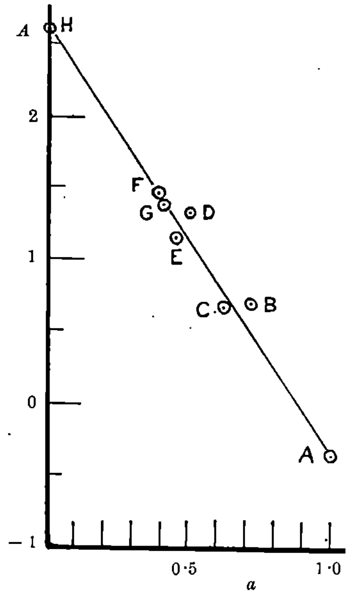
The energy used is χ for 1, $-A$ for 2 and $-S$ for 3, a total of $\chi - A - S$. This is put equal to E, which can be determined experimentally. S may be calculated from the modified Born equation[2] for a singly charged anion in water, and $\chi = 4{\cdot}52$ eV. The radius of the ion needed in the Born equation can be calculated from the molar volume. For triphenyl methyl, $S = 1{\cdot}46$ eV.; hence, $A = +\,2{\cdot}62$ ($\pm$ 0·05) eV.

Triphenyl methyl is the only one of the compounds considered for which previously determined values of A have been found. In these cases, by methods completely different from the present, A was 2·56 ± 0·2 eV.[3], and 2·09 ± 0·2 eV.[4].

Molecule	E^6 (eV.)	S (eV.)	A (eV.)	Addition of sodium[5]
Benzene	2·87	2·01	−0·36	nil
Diphenyl	2·15	1·67	+0·70	nil
Naphthalene	1·99	1·86	+0·67	slowly
Stilbene	1·61	1·58	+1·33	
Pyrene	1·57	1·79	+1·16	
1 : 4 Diphenyl butadiene	1·46	1·59	+1·47	rather easily
Anthracene	1·42	1·72	+1·38	easily
Triphenyl methyl	0·44	1·46	+2·62	very easily

Results for other molecules are quoted in the accompanying table. The order of electron affinity increase is similar to the order of readiness of addition of alkali metals[5]. Thus the values of A have considerable qualitative and some quantitative support.

A seeming objection to the inclusion of S as a potential-determining factor is that the reduction (half-wave) potential was found[1] to give a linear plot against the coefficient, a, of the molecular orbital resonance integral, which is, of course, independent of solvation effects. But a plot of $E + S$ against a is also linear (with deviations attributed to theoretical approximations in the admittedly first-order calculation of a). Thus A depends linearly on a (see graph), and Maccoll's general conclusion[1] is unimpaired, although he made no allowance for solvation effects.



A, benzene; B, diphenyl; C, naphthalene; D, stilbene; E, pyrene; F, 1 : 4 diphenyl butadiene; G, anthracene; H, triphenyl methyl

Benzene is interesting because, of the molecules listed, it alone has a negative electron affinity. Benzene has not been reduced polarographically. Conditions to enable this to be done are now being sought in my laboratory. The point shown on the graph is estimated from the known a by Maccoll's original curve, corrected by the appropriate S.

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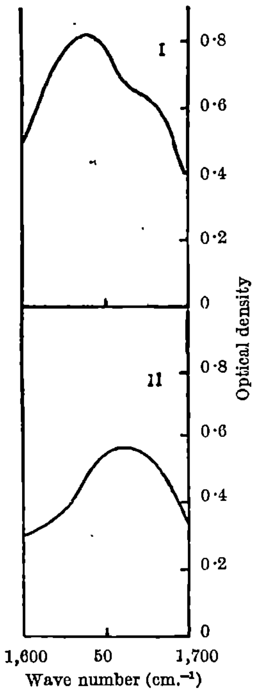
Chain Configurations in Natured and Denatured Insulin: Evidence from Infra-red Spectra

THE range of techniques available for studying the denaturing and renaturing of proteins has recently been increased by the observation[1] that a change from the extended (β) chain configuration of a synthetic polypeptide to the folded (α) form is accompanied by an increase in the frequency of the infra-red absorption band characteristic of the $C = O$ peptide link. There is already evidence[2] that some denaturing processes in proteins are accompanied by an unfolding of polypeptide chains, producing the extended β-form, and it seemed of interest to see if evidence on this point could be obtained from infra-red spectra.

Insulin can be denatured and renatured (in the sense that the biological activity can be removed and later restored) by simple processes. The subject has been reviewed by Sanger[3]. We have measured the $C=O$ absorption band of these two forms of insulin; these are shown in the accompanying figure, whence it may be seen that the frequency does indeed diminish as a result of denaturation. Crystalline natured insulin gives a curve similar to that of insulin precipitated from aqueous phenol.

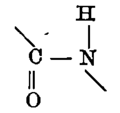
Dr. Lens's observation[4] that insulin can be renatured by aqueous phenol (which he has described to us) directed our attention to the possibility of producing similar results with *m*-cresol. Bamford, Hanby and Happey[5] have shown that synthetic polypeptides when cast from solution in *m*-cresol are predominantly in the α-chain configuration, whereas when cast from solution in formic acid they are in the β-form. It is therefore possible to pass a given synthetic polypeptide through an α–β transformation and back again simply by successive solution and reprecipitations from these two solvents. In addition, it is possible to follow the various stages by means of the $C=O$ frequency-shift described above.



I. Insulin denatured by boiling in dilute HCl solution.
II. Insulin precipitated from aqueous phenol (natured)

A sample of crystalline insulin was passed through the same cycle. It showed exactly the same kind of frequency shifts of the $C=O$ band as had been observed in synthetic polypeptides. The film cast from formic acid at a high temperature gave a curve similar to that of the denatured protein (I in figure). It was confirmed by chemical analysis that there was no formic acid in the specimen. This material was redissolved in *m*-cresol and recast as a film. A curve similar to the natured form (II in figure) was obtained.

These results are consistent with the view (though not perhaps excluding other explanations) that natured insulin consists of polypeptide chains in the same α-fold as α-synthetic polypeptides, and that denaturation is accompanied by an extension of the chains into the β-configuration. The type of α-fold, which has been suggested in earlier papers[6,7,1], enables the α–β transformation to occur without any marked change in the packing of side-chains but merely by rotation of the



groups about bonds attached to the asymmetric carbon atom. No rotation of side-chains about the chain axis is required. With this kind of fold in natured insulin, the α–β transformation could occur without breaking the disulphide linkages between chains. It is known that these disulphide linkages must be preserved[3] if the denaturation is to be reversible.

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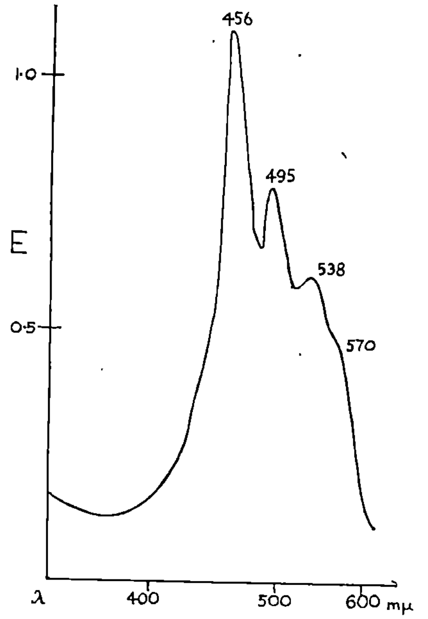
A Subsidiary Shell Pigment of *Haliotis cracherodii* Leach

IN previous communications[1], I have described investigations of the chief blue pigment extracted by acids from the shell of the gastropod *Haliotis cracherodii* Leach. Important evidence has been produced by Tixier and Lederer[2] against our view, based largely on spectroscopic findings, that this pigment is an indigoid. A joint study of the blue pigment, in collaboration with these workers, is in progress. In the meantime, we have obtained one of the accompanying yellow pigments in sufficient yield to perform spectrographic studies upon it, and upon its zinc complex.

The yellow material forms one of the discrete fractions obtained by chromatography in chloroform upon talc of the mixture formed when shell extracts in 3N hydrochloric acid are shaken with amyl alcohol and the epiphase evaporated to dryness. It is soluble in ether and in chloroform, is precipitated as an amorphous powder by adding petroleum ether to the chloroform solution, and shows no visual absorption bands in neutral solvents. Spectrophotometry shows well-defined maxima at about 4400 and 4900 A.

Upon addition of methanolic zinc acetate, a crimson zinc complex, reversibly decomposed by acids, is formed. This material has a strong four-banded spectrum and gives an orange fluorescence in ultraviolet light. It, too, is precipitated by petroleum ether from chloroform, but attempts to crystallize it have so far failed. The plot obtained with the Holiday continuous-recording spectrophotometer is shown in the accompanying graph. The sample examined was homogeneous, both in the free state and as the zinc complex, upon repeated chromatography.



The absorption spectrum is not consonant with any of the commoner natural pyrroles. The behaviour of the zinc complex, however, is more suggestive of a pyrrolic material than of any other type of pigment, and in no way resembles an indigoid. Its occurrence in association with the blue pigment is therefore presumptive evidence in favour of the view expressed by Tixier and Lederer.

Acknowledgment is due to Dr. E. R. Holiday, of the Medical Research Council Spectrographic Unit, for the spectrophotometric studies.

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Chromatographic Analysis of Eucalypt Kinos

KINOS are dark cellular accretions or astringent exudations containing phenolic substances. They are commonly seen as vitreous lumps on the bark, or as veins in the timber, of many eucalypts, and are locally known as 'gums'. The kinos of certain eucalypts have been examined by the Williams and Kirby's solvent ascent modification[1] of the paper partition chromatographic technique[2].

Butanol – acetic acid – water (40–10–50 per cent by volume) has been used successfully to resolve quebracho tannin[3], flavanoid pigments[4], etc., and also by me for the examination of the extracts of the timber of *Acacia decurrens*, Willd., *Sloanea woollsii* F. v. M., *Litsea reticulata* Benth. and *Alstonia scholaris* R.Br. This solvent gave poor resolution of the components of the eucalypt kinos, and phenol–water solvent, although more suitable, did not sharply resolve them.

Many new solvent mixtures were tried and their efficiency gauged by observing the relative positions and intensities of fluorescence of the components when the paper sheets were viewed under ultra-violet light. The most suitable solvents were found to be: (*a*) a mixture of equal volumes of phenol and $2N$ acetic acid to which 0·3 per cent sodium chloride was added; (*b*) a mixture of equal volumes of phenol and an aqueous solution $2N$ with respect to both acetic and hydrochloric acids; (*c*) ethanol–benzene–water (40–20–40 per cent by volume).

Solvents (*a*) and (*b*) gave comparable R_F values; but solvent (*b*) was more suitable for samples of kino which had been collected for some time, when some components were not so strongly fluorescent in the absence of hydrochloric acid. Solvent (*c*) resolved only those components which had a high R_F value in the phenol solvents.

The phenol was purified by a hitherto unreported method; it was agitated for a few minutes with 4 per cent of its weight of concentrated sulphuric acid – potassium dichromate mixture (90–10 per cent by weight), heated under reflux at about 150° C. for one hour, then poured off and distilled under vacuum using an efficient splash-head. After this treatment the phenol remained completely colourless for several months.

Relatively large amounts of kino (6–15 mgm.) were necessary to enable later detection of the components. The kino of *E. calophylla* R.Br. (marri) was resolved into at least twelve components (six fluorescent and six detected by Tollen's reagent), that of *E. corymbosa* Sm. into at least thirteen components (five fluorescent, seven by Tollen's reagent, one by both), that of *E. goniocalyx* F.v.M. into at least eleven components (four fluorescent, five by Tollen's reagent, one by both, and one carbohydrate by Partridge's reagent[5]).

Aromadrendrin[6] had an R_F value of 0·79 and a green fluorescence in ultra-violet light.

This work will be published more fully elsewhere.

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Chemical Delignification of Flax Straw and Other Cellulosic Materials

THE retting of flax, which is a delignification and a degumming process brought about by micro-organisms, has been used in Europe for many years in the linen industry. Retting is usually applied to the straw of a variety of flax which has been developed and grown to give long stems. Moreover, the straw is harvested before lignification has proceeded too far.

In the United States of America, a large amount of flax is grown for its seed and not for its fibre, and consequently the straw forms a relatively large agricultural waste product. Investigations have been proceeding for several years in this University into the possible utilization of seed-flax straw. One object of these studies was to devise a chemical method of delignification or retting which could be applied to seed-flax straw in which lignification has proceeded to completion, so that waste straw could be used for making linen. Chemical methods of delignification do not usually give a suitable product for making linen yarn because the cellulose fibres are either weakened or shortened[1] to such an extent that spinning cannot be accomplished. The delignification procedures used in the paper industry, for example, are much too drastic to produce the effect of natural retting, inasmuch as they usually result in partial or complete pulping of the bast fibres[2]. The method for the preparation of holo-cellulose which involves the use of chlorine dioxide[3-6] has, however, been applied with some success to the delignification of flax roving which has been freed from as much of the woody shives as possible[7]. More recently, we have found that one treatment of seed-flax straw or roving for two hours at 155° C. under pressure with an aqueous solution containing sodium hydrosulphite ($Na_2S_2O_4$) frequently called 'hydros' (2 per cent) and sodium hydroxide (2 per cent) results in complete extraction of the lignin. Furthermore, the residual cellulose fibres can readily be spun into yarn.

Apart from its possible industrial application in the linen industry and its potential use for the determination of 'holo-cellulose' and lignin, the alkaline hydrosulphite reagent enables the constituents of cellulosic materials to be separated and hence investigated. Thus, flax straw has afforded cellulose, lignin, hemicellulose or flax gum and a pectic acid[8]. The cellulose remains undissolved by the reagent. The lignin may be precipitated by acidification of the alkaline extract as a light-coloured amorphous powder. The flax pectic acid can be separated as a salt, and the flax gum or hemicellulose is recoverable from the mother liquors.

This alkaline hydrosulphite method can be used for the delignification of grains, leaves and straws, and preliminary experiments with various kinds of wood indicate that the reagent is capable of extracting lignin from these cellulose-containing products. Further details of this work will appear elsewhere.

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Induced Vitamin-requiring Mutants of *Chlamydomonas*

A FEW instances of vitamin requirements among green algæ have been recorded. Since the isolation of algæ has usually involved an enrichment in a mineral solution, which would select against species with organic growth-substance requirements, our present knowledge of algal physiology is strongly biased in favour of completely autotrophic forms.

Chlamydomonas chlamydogama Bold has been recently shown to require, *inter alia*, vitamin B_{12} [1], while several other species of *Chlamydomonas* have been reported to require aneurin for rapid growth under heterotrophic conditions[2]. The aneurin requirements of some colourless counterparts of *Chlamydomonas* (*Polytoma* spp., etc.) have been extensively investigated by Lwoff and Dusi[3].

Following ultra-violet irradiation of the completely autotrophic *Chlamydomonas Moewusii* Gerloff, two mutant clones have been isolated which require exogenous vitamins for optimal growth. One, *M.*336, requires aneurin, responding to concentrations as low as 10^{-10} gm. per c.c. The complete molecule can be replaced by the pyrimidine moiety alone, indicating that the synthetic ability respecting thiazole is unimpaired. Another mutant, *M.*701, requires *para*-aminobenzoic acid, replaceable by aniline at a relative efficiency of the order of 1 per cent. (In this connexion, it may be mentioned that inhibition of wild-type cells by sulphanilamide can be reversed by *para*-aminobenzoic acid, but not by aniline.) *M.*701 has been crossed with wild-type: in the progeny of zygotes analysed, dependence on *para*-aminobenzoic acid appears to behave as a single Mendelian character, showing no linkage with mating-type.

The experimental induction of biochemical mutants in algæ provides a fruitful approach to the study of the comparative physiology of autotrophs, parallel with that now extensively investigated in heterotrophs such as *Neurospora* and *Bacterium coli*.

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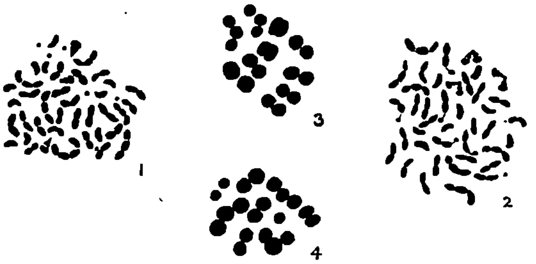
Mango: its Allopolyploid Nature

THE mango, a favourite tropical fruit, which is widely cultivated in India, belongs to the Malaysian genus *Mangifera* Linn. (fam. Anacardiaceæ). Taxonomic study[1] shows that it contains forty-one valid species, three of which, *M. indica* L. (wild and cultivated), *M. sylvatica* Roxb. (wild in the hilly forests of north-east India), and *M. khasiana* Pierre (a species of doubtful occurrence) have been reported from India. About a thousand cultivated varieties of mango occur in India, all of which are included in the single species, *M. indica* L. They differ from one another mainly in fruit characters, on the basis of which they have been classified into three groups: round-, ovate-oblong-, and long-fruited[2]. The morphology of the innumerable varieties shows a gradual, continuous change in their characters, intergrading in range.

Information on the cytogenetics of the species of Anacardiaceæ as a whole is very meagre, especially about *Mangifera* L., only the chromosome number of *M. indica* being known. Maheswari[3] first reported the number doubtfully as $n = 24–26$. Roy[4] reported the haploid number of four varieties as ranging between four and eight. Recently, Janaki Ammal[5] mentioned only the number as $2n = 40$. I have carried out cytogenetical studies on this important genus.

The three species investigated—*M. indica* L. (including twenty-three grafted varieties, and one wild race), *M. sylvatica* Roxb. and *M. caloneura* Kz.

(a Burmese wild species)—show striking stability in their chromosome numbers, all having $n = 20$ and $2n = 40$ chromosomes (Figs. 1 and 2). The chromosomes are $0{\cdot}4$–$2{\cdot}0\,\mu$ long, and show minute differences in their size and morphology, on the basis of which they can be separated into eight distinct types. The total number of satellites and secondary constrictions in a complement varies between eight and sixteen, and corresponds generally with the number of nucleoli, as determined by the Feulgen Light-green technique[6]. An analysis of the karyotypes indicates that the varieties of mango and allied species differ mainly in the different assortments of those eight distinct chromosome types ; each complement showing slight variation from the other, without any sharp differentiating feature. The phenotypic and the karyotypic characters exhibit an interesting parallelism in the slow, inter-grading, continuous changes in their diagnostic features.



(1) *M. sylvatica* ; (2), (3) *M. indica* ; (4) *M. caloneura*. (× 2,840)

Pairing and disjunction of the chromosomes in the pollen mother-cell are regular, and twenty bivalents are clearly seen during diakinesis and metaphase (Figs. 3 and 4). No formation of multivalents or any other peculiarity has been observed. During metaphase, the bivalents aggregate in groups of four, three and two due to secondary association. The maximum association of the bivalent groupings is found to be into eight units, which is possibly the basic number for the genus, as is also suggested by the eight distinct chromosome types distinguished on the basis of their morphology. The basic number 8 may also be a derived number from 5, as the allied genera *Rhus* and *Semecarpus* have respectively $2n =$ 30 and 60 chromosomes.

These observations, namely, high chromosome number, a correspondingly high number of nucleolar chromosomes, secondary association, regular pairing and disjunction of bivalents, absence of multivalent formation, and good fertility (apparent sterility as determined from pollen analysis is between $1{\cdot}2$ and 12 per cent) establish the allopolyploid origin of the mangoes and allied species. The innumerable varieties have become differentiated from the original type or types primarily through gene mutations, the selected type being preserved under cultivation through vegetative propagation by grafting. The great diversity among mango varieties in India is also to be explained as due to their cultivation for a long period, thereby giving opportunity for hybridization and forces of selection to operate. Selection by man for about four thousand years must have had also an important role in the process.

Thanks are due to Prof. S. P. Agharkar, for his advice and interest in the work, and to Dr. P. N. Bhaduri for help and encouragement. The investigation was carried out with the financial assistance of the Indian Council of Agricultural Research, at the Botanical Laboratory, University of Calcutta.

SUNIL KUMAR MUKHERJEE
Botany Department,
University, Delhi. March 1.

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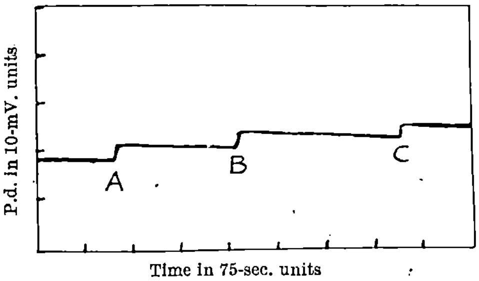
The Alleged Membrane Potential Produced by Diffusion in Nerve and Muscle Fibres

IN a recent communication in *Nature*, Ling and Gerard[1] state that support for the membrane potential of nerve and muscle being a diffusion potential is afforded by the rectilinear relation between the logarithm of external potassium concentration and the measured membrane potential according to the well-known Nernst equation. For a single fibre of the frog sartorius this value is reported to be 95 millivolts, which is the approximate theoretical value.

These interesting results can also be interpreted in terms of phase-boundary potential in which the solubility of the electrogenic substance in lipoid (not the diffusion) is the important factor. We have repeatedly pointed out[2,3] that the logarithmic relation of the Nernst equation applies to phase-boundary potentials. The logarithm of the concentration of the electrolyte in the aqueous medium bears a rectilinear relation to the potential established by the electrolyte which penetrates and ionizes in the oil layer. No 'membrane' in the sense of Ostwald[4] or Bernstein[5] is necessary, and this logarithmic relation cannot be brought forward as 'proof' or 'support' for the existence of a diffusion potential in a 'membrane'. We know that the exterior of a nerve fibre (where the potential develops) is an interface between oil and aqueous medium. Electron microscopy[6] has failed to reveal the presence of any 'pores' in the nerve 'membrane'.

It seems logical to suppose that the potentials in nerve are phase-boundary potentials set up by organic substances (especially those containing tetracovalent nitrogen[7], which are electrogenic both in living nerve[8] and in 'test-tube' models consisting of an interface between oil and saline[9]). Accordingly, we have devised models in which tetraethyl onium, acetylcholine and other drugs generate negative phase-boundary potentials in a U-tube of oil immersed in saline (conditions duplicating those at the surface of the living fibre). Under these conditions, simple electrolytes like sodium and potassium[10] have very feeble electrical action, and it is unlikely that they play any part in the production of action currents. The accompanying record shows the failure of potassium chloride to establish appreciable electrical potential at the phase-boundary between an oil (guaiacol) and saline *in vitro*. Ordinates represent electrical potential difference between the two sides of the oil layer ; abscissæ show time in increments of 75 sec. each. Reading from left to right, the upward deflexions are produced by the well-known electrical negativity of potassium chloride. At *A*, 500 mgm. of potassium chloride was added to 200 c.c. of saline on one side of the oil-layer, which consisted of guaiacol. At *B*, 1 gm. of potassium chloride was similarly introduced ; and at *C*, the massive dose of no less than 2 gm. potassium chloride was placed in the



saline medium, which now contained a total of 3·5 gm. of the potassium salt. (Exp. No. 92 *E*. Temp. 19° C. A Leeds and Northrup Speedomax phase-motor recorder was employed.) It is concluded that potassium has negligible electromotive action in a saline medium (0·85 per cent sodium chloride). In contrast to the effects of sodium and potassium, alkaloids have extraordinary phase-boundary potentials, as we have previously described[2].

In conclusion, it would appear that there is no convincing evidence for the existence of membrane potentials produced by diffusion of potassium or sodium in nerve fibres.

T. Cunliffe Barnes
R. Beutner

Department of Pharmacology,
Hahnemann Medical College and
Hospital of Philadelphia. April 27.

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Helical Fibrillar Structure of Vegetable Fibres

We have seen the comments[1] of Sen and De on our note[2]. It seemed unnecessary to mention that the paired-variate method was used in each case in getting the standard error of the difference, the bundles used for each pair of tests (with *S*- and *Z*-twist) being obtained by dividing a sub-sample into two parts. If the results are examined in the light of this explanation, it will be seen that in the case of the breaking-load the difference between the *S*-twist and *Z*-twist results is highly significant for both samples.

The error in reading turns per inch in the breaking-twist tests was of the order of 0·01 turn per inch in a single observation. The error in reading the diameter of twisted bundles was of the order of 0·007 cm. in a single observation; the magnification of the projected image was 15 diameters, and we could measure the diameter of the image to the nearest millimetre.

As regards torsional rigidity, our remarks were carefully worded. We attribute the small differences to the effects of damping and, possibly, of permanent deformation, which would act differently according to whether *S*- or *Z*-twist was initially applied. Only small differences would be expected, and only small differences are suggested by our results.

Regarding the remarks in the last paragraph of Sen and De's letter, we are aware that our results are a measure of the torque required to produce a twist of one complete turn in unit length of a bundle of fibre-strands.

Our provisional view is that the thick secondary walls are mainly responsible for the effects observed, and that the fibrils of the secondary walls have a small *Z*-twist. The drying and wetting twists of many vegetable fibres are very lively, and it seems likely that the direction of yarn twist has some practical significance. The 'bees'-knees' that form in wet-spun flax yarns after drying are an example. Moreover, a difference of as much as five per cent in the strengths of jute yarns with *S*- and *Z*-twist is quite a possibility.

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[2] *Nature*, **163**, 19 (1949).

A Recent Deposit of Bird Bones in the Falkland Islands

West Point Island lies off the north-west corner of west Falkland and only about a quarter of a mile off-shore. It has been occupied as a small sheep farm for many years, and like everyone else in the Falklands the people of the Island burn peat. The peat-bog, that is the place whence the peat is brought, is situated near the upper end of a valley, roughly one and a half miles long and half a mile wide, which runs up from sea-level at the north to the top of a steep cliff at the south end. The area covered by the peat bog lies at an altitude of approximately 600 ft. It has been worked over by the removal of successive layers of one yard in thickness; in some places three such layers have been extracted, and beneath the lowest, that is, at a depth of nine feet from the original surface, a bone deposit was discovered some fifteen or twenty years ago.

The deposit has been examined at different times by both of us during rather short visits to the Island; but there has been no opportunity to ascertain the horizontal extent of it by excavation. Vertically it is only a few inches thick. One of us (J. E. H.) considered that the bones accumulated in the matrix of the deposit, which is of a clayey nature, prior to the formation of the peat at this site; the other (G. H.-S.) considers that the stratum of clay lies between the peat now being worked and an older peat underneath.

The bones are very plentiful; indeed, in the appropriate layer one cannot insert a spade without cutting through them. They are exclusively avian and include penguin, snipe, finch (*Melanodera* ?) and a carrion hawk—probably *Ibycter australis*. All these birds are still quite common except *Ibycter*, and it was plentiful enough a hundred years ago. The bones themselves are fragile.

The depth at which the bones occur precludes any human agency, and we consider that the peat covers the site of a pond which has now vanished. One may believe that the fresh water proved attractive to the birds, and it seems not unlikely that the mud may have been of such a texture as to entrap the unwary.

G. Hattersley-Smith
J. E. Hamilton

Falkland Islands Dependencies.

FORTHCOMING EVENT

Thursday, August 3

Fauna Preservation Society (at the Zoological Society of London, Regent's Park, London, N.W.8), at 4.30 p.m.—General Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Assistant (with a University degree or equivalent, together with industrial and teaching experience) for the Radio Communications Section of the Department of Electrical Engineering and Applied Physics—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4 (August 5).

Chemists and Chemical Engineers (Senior Scientific Officer and Scientific Officer grades, unestablished) at a Ministry of Supply Research Establishment near London: (*a*) Physical Chemist with a training in chemical engineering and an aptitude for plant development work, (*b*) Chemist with research experience in some branch of physical chemistry, (*c*) Physical Chemist with experience in propellant explosives with, preferably, some knowledge of weapon techniques, (*d*) Chemist with plant experience in the liquefaction and purification of gases—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.405/50A (August 7).

Graduate Assistant in Biochemistry in the Pathology Department—The Secretary, Queen Elizabeth Group Hospital Management Committee, Hackney Road, London, E.2 (August 7).

Scientific Officer (Chemist, with a University degree including honours chemistry, preferably with zoology and biology as subsidiary subjects) in the Department of Agriculture for Scotland Food Infestation Control Section in Glasgow—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.271/49A (August 7).

Principal Scientific Officer (Research Engineer) to take charge of development work on food processing in a Ministry of Food experimental factory at Aberdeen—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.48/50A (August 8).

Scientific Officer (with honours degree in chemistry, with postgraduate experience or an honours degree in agricultural chemistry) in the Chemical Research Division of the Ministry of Agriculture—The Director of Establishments, Ministry of Finance, Stormont, Belfast (August 10).

Senior and Junior Fellowships at a Ministry of Supply Research Establishment in South-west England, for research into specialized aspects of physiology and pharmacology connected with the injurious effects of toxic materials and with methods for their treatment—The Ministry of Supply, Est.3(c)1, Adelphi, Strand, London, W.C.2 (August 10).

Experimental Officers at a Ministry of Supply Experimental Establishment in South-West England: Physicists (Ref. A.196/50) with a good knowledge of physics and mathematics, preferably to degree standard; Engineers (Ref. C.368/50) with experience in design and development of light engineering machinery; and Chemists (Ref. F.435/50) with a good knowledge of chemistry, preferably to degree standard—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 12).

Lecturer in the Department of Chemistry (with a degree or equivalent qualification in chemistry, and a particular interest in physical and/or inorganic chemistry)—The Principal, Derby Technical College, Normanton Road, Derby (August 12).

Assistant Lecturer in the Department of Chemistry (with special qualifications in Organic Chemistry), and a Research Fellow in Organic Chemistry—The Clerk, Birkbeck College, Fetter Lane, London, E.C.4 (August 15).

Permutit Company Senior Studentships (2) in Chemistry, Engineering or Chemical Engineering—The Master, St. Catharine's College, Cambridge (August 15).

Research Fellowship in Mathematical Physics—The Secretary, The University, Birmingham 3 (August 15).

Engineer (Principal Scientific Officer or Senior Scientific Officer grade) (Ref. C.380/50) to control section studying problems of liquid fuel rocket combustion chambers, atomizers, nozzles, etc., a Physicist (Principal Scientific Officer or Senior Scientific Officer grade) (Ref. A. 205/50) to study problems relating to rocket motors, and Chemists (Senior Scientific Officer or Scientific Officer grade) (Ref. F.216/50) for research and development work on solid propellant rocket motors, at a Ministry of Supply Research and Development Establishment in the Home Counties—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 17).

Plant Pathologist at the Forestry Commission Research Station at Alice Holt, Farnham, Surrey, to carry out an investigation into a disease of sycamore trees in Great Britain—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (August 21).

Assistant Lecturer (with a special degree or its equivalent in botany) in the Department of Botany—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (August 25).

Physicists with honours degree in physics or engineering (Principal Research Officer grade) for wool textile research—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (August 28).

University Lecturer in Theoretical Electrodynamics and Radio—Miss J. Bird, Chemical Laboratory, Cambridge (August 30).

I.C.I. Fellowship in Chemistry or Physics, or a related subject, tenable at Durham or Newcastle—The Registrar, University Office, 46 North Bailey, Durham (August 31).

Lecturer in Electrical Engineering at University College, Dundee—The Secretary, The University, St. Andrews (August 31).

Lecturer (Grade II) in Industrial Metallurgy—The Secretary, The University, Birmingham 3 (August 31).

Research Assistant in Physiology—The Nuffield Professor of Industrial Health, King's College, Newcastle-upon-Tyne (August 31).

Senior Lecturer in Microbiological Chemistry at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Studentship in Physical Chemistry, with special reference to photochemistry and spectroscopy—The Secretary, Department of Physical Chemistry, Free School Lane, Cambridge (August 31).

Chair of Microbiology in the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

Research Fellow (Physical Chemist willing to develop radio isotope technique) in the School of Metallurgical Research, University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

University Lecturer or University Demonstrator in the Engineering Department—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (September 2).

Chair in Metallurgy—The Registrar, The University, Sheffield (September 4).

Lecturers (2) in the Department of Mining Engineering, University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

Studentship for fundamental research in some field which may be relevant to the food industries of Northern Ireland—The Secretary, Queen's University, Belfast (September 21).

Assistant Director in the Commonwealth Bureau of Pastures and Field Crops, Aberystwyth—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (October 1).

Senior Lecturer in Chemical Pathology—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (October 1).

Applied Mathematicians in the Technical Section, (*a*) a Senior Mathematician to direct a small mathematical sub-section undertaking varied and, to some extent, unpredictable work, including the study of economical employment of novel processes, stability of complex plant operation, problems in air and gas dynamics, etc., and (*b*) a Mathematician to assist with this work—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Assistant Biochemist—The Administrative Officer, City Hospital, Nottingham.

Biochemist or Chemist, for research on fundamental problems related to the nervous system—The Director, Neuropsychiatric Research Centre, Whitchurch Hospital, Cardiff.

Chemist or Biochemist, to study metal-organic complexes in relation to nutrition—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Chemist (with a good University degree in chemistry and Associateship of the R.I.C., and experience in biochemistry and pathology as related to crime) in the Medical Department, Gold Coast—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27106/10/49.

Demonstrator in Pharmacy—The Registrar, The University, Nottingham.

Graduates (3) with first- or second-class honours in physical chemistry or physics, for fundamental work on combustion of solid fuels—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

Industrial Research Chemist (with an honours degree in chemistry and experience in managing an industrial research department) to take charge of the Applied Research Laboratories in the Ministry of Supply Division of Atomic Energy (Production) at Seascale, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Lecturer in Chemistry, to teach to Intermediate and Final B.Sc. Degree standard—The Clerk, Northern Polytechnic, Holloway Road, London, N.7.

Lecturer in the Department of Chemistry, with special qualifications in inorganic and/or physical chemistry—The Secretary, Royal Technical College, Glasgow.

Lecturer (with honours degree in mathematics) in the Department of Pure and Applied Science—The Registrar, Loughborough College, Loughborough, Leics.

Meteorologists in the Sudan Government Meteorological Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Meteorologist'.

Physicists or Physical Chemists for (*a*) general investigations on the physics of felt making, and (*b*) investigations on the physics and physico-chemical properties of emulsions of shellac in alkali and their absorption and adsorption by felts—The Director, British Hat and Allied Feltmakers Research Association, Stanley House, Manchester Road, Fairfield, Droylsden, Manchester.

Professor of Physics, a Lecturer in Mathematics, and a Lecturer in Geography, at the College of Arts and Science, Baghdad—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

Senior Assistant in Civil Engineering in the Building Department, and an Assistant in Biology in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

Soil Physicist in the Department of Agriculture, Sierra Leone, for investigations in connexion with the reclamation, drainage and cultivation of paddy rice on very acid soil—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

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EDUCATION AND DEVELOPMENT IN THE COLONIAL TERRITORIES

ONE reason for welcoming the annual report on the Colonial Territories* is that it places in its proper perspective the scientific work being conducted in those Territories and which is described more fully in the independent report on "Colonial Research". The present report, for 1949–50, is no exception. Indeed, the ten pages of the report dealing with research and surveys not only indicate the bearing of the work to be described more fully in a forthcoming report on economic and social development and its relation to political and constitutional developments, but also contribute to giving a clear picture of the various ramifications of international collaboration in this field. The diary of events of Colonial interest is also of service in this connexion. Indeed, the whole report is an invaluable aid to informed discussion on proposals for technical assistance to the backward areas under President Truman's 'Fourth Point', on particular projects such as the groundnuts scheme or on colonial welfare and development generally.

Compared with the previous report, the emphasis on the man-power situation is less marked. Recruitment to the British Colonial Service was at a higher level than in any pre-war year; but there is still a shortage of recruits in several branches, particularly some of those calling for professional qualifications. This shortage is attributed partly to the continuing high-level demand in Britain itself, but even more to the great expansion in the Colonies as a result of their plans for development.

This position is particularly well illustrated in regard to the developments in education during the year, and especially in higher education. The report reviews briefly those rapid developments in Colonial university education recorded in last year's report from the Inter-University Council for Higher Education in the Colonies, which formed the subject of an article by Mr. W. Adams, secretary of that Council, in a recent issue of the *Universities Quarterly*. The present report notes further that teaching in the Faculty of Arts at the University College of the West Indies and in agriculture in the Faculty of Agriculture and Veterinary Science at University College, Ibadan, will begin in October of this year. An Advisory Committee on Colonial Colleges of Arts, Science and Technology was set up by the Secretary of State at the end of 1949 and, in addition to advising on general development and the selection of staff, this Committee is responsible for recommending grants from a sum of £1,125,000 which has been made available for the three regional colleges in West Africa under the Colonial Development and Welfare Act. Principals-designate were appointed during the year for the projected college in Nigeria and for the reconstituted Fourah Bay College in Sierra Leone, and are at present determining sites and planning initial courses.

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* The Colonial Territories (1949–50). (Cmd. 7958.) Pp. viii+158. (London: H.M. Stationery Office, 1950.) 4*s*. net.

"These colleges are expected to provide whatever courses in higher technical and commercial education are most needed. They will also undertake the training of teachers and of social welfare and community development workers, and, pending further developments in secondary education, may provide general teaching up to higher certificate standard. They are likely to become centres of adult education and of cultural and technological development generally. . . . They will also provide certain courses which at present students can follow only in the United Kingdom or elsewhere overseas."

The report adds: "Provided that the necessary staff can be found, the colleges will make an incalculable contribution to the social and economic development of the West African territories"; but the general implications are brought out better in Mr. Adams's article. Mr. Adams points out first that the development and welfare plans of the Colonies call for trained personnel in large numbers, and that in the main these specialists must come from the Colonial territories themselves. The pace of development, however, is being forced from outside, by political and constitutional as well as economic and social changes; the universities are accordingly being faced with difficult decisions in their expansion. These points are scarcely noted in the Colonial Territories report, although the political and constitutional changes are for the most part well emphasized.

The main problem is not entirely one of staff, although that factor is involved. Difficulties in recruiting staff have not, Mr. Adams holds, been as important a source of delay as was at first feared, and he comments on the encouraging response from the Dominions in recruitment. Moreover, while secondment of staff from universities in Britain has so far played a small part, secondment may become more common as the staff position eases at home and in the Dominions. The Colonial universities and colleges have also begun to make contacts at the research-student level.

The real difficulty is presented by post-secondary education. In considering whether a subject is appropriate for university teaching, a university in Britain can safely assume that provision can be made elsewhere for it. When a Colonial university, however, is asked to undertake training tasks in fields or at standards which by home conventions are not those of universities, to refuse may mean that the training is not given at all; on the other hand, to accept may invest the work with a social prestige which will impede its transfer to another type of institution later. Mr. Adams stresses the importance of diversifying the educational opportunities for the Colonial student after his secondary education in order to avoid serious repercussions on the success and speed of the development of the university institutions. Moreover, unless public opinion is convinced of the value of such experiments as the regional colleges proposed for West Africa, the colleges are scarcely likely to succeed even if the staffing problems are surmounted.

There may well be no single remedy; but the need for educational development at the primary, and especially the secondary, level is well brought out in other sections of the Colonial Territories report, and the magnitude of the consequent demand for trained man-power and the acuteness of the attendant problem of standards scarcely need to be stressed. That is apparent in the general survey which forms Part 1 of the report, in which the progress recorded in all spheres of education leads to no complacency. Among the events of the year in the educational field was the graduation of the first group of teachers from Batu Lintang, the teacher training college set up in Sarawak. Stress is also laid on the community development schemes, which differ from territory to territory but have as one recurring feature a compact team of experts working systematically in a given area, and on the striking development of the libraries of the Colonial university institutions, sometimes assisted by capital grants from Colonial Development and Welfare funds. The provision of vernacular literature is another problem, and the East Africa Literature Bureau and the Joint Publications Bureau of Northern Rhodesia and Nyasaland set up in 1948 are abundantly justifying their establishment. The Mass Education Clearing House set up in the University of London Institute of Education is also playing a valuable part.

Reviewing the health services, the report emphasizes that all available statistics point to striking improvements in health in the British Colonial Empire during the past decade, and the improvement is attributed largely to effective control of malaria, until recently the chief killing-disease in the world. Here the contribution of science is unmistakable. The complete eradication of the malaria-carrying mosquito from Cyprus announced in January 1950 was made possible mainly by repeated DDT spraying of every possible mosquito-breeding place over a period of three years. By similar methods, some ninety-five per cent of the people of British Guiana are now enjoying protection from malaria; and in Mauritius, too, the full-scale programme of mosquito eradication now in progress should at least greatly diminish the disease.

It is possible that DDT may prove to be almost equally effective in combating the tsetse fly, the carrier of sleeping sickness in Africa. Experiments in Tanganyika with insecticide smoke from aircraft have already demonstrated that, under certain conditions, all the flies can be killed in blocks of infested bush some five to six square miles in extent, while the survey also refers to investigations in East and West Africa into problems of tsetse-borne diseases in cattle. Other new drugs offer hope that diseases prevalent in the tropics will be brought under control far more rapidly than could have been foreseen a few years ago: for example, hope is offered for lepers by the development of certain drugs, and a wide application of B.C.G. vaccine in the treatment of tuberculosis is contemplated.

The importance of the scientific contribution was also well brought out in a paper which Sir Harold Tempany read before the Society of Chemical Industry last January. Dealing with the agricultural problems of the Colonial dependencies, Sir Harold touched on many problems affecting economic development which are mentioned in this report and indicated some of the deficiencies in our existing knowledge of such matters as tropical soils, climatic conditions, the fertilizer requirements of tropical crops and other factors which affect both plantation and peasant agriculture alike. These gaps, like the surveys, which both Sir Harold and the Colonial report urge, depend on scientific study and research just as much as the new measures for the control of animal diseases or the control of pests and diseases of plant crops, whether by breeding immune or resistant strains or varieties, or by biological or chemical methods.

Here and elsewhere, as in his reference to the high importance of the co-ordination of research and development in British territories with those in adjoining countries, especially in such matters as the conservation of soil or control of disease, Sir Harold's views run parallel with many passages in the present survey of the Colonial Territories. The shortage of senior technical staff which continues to be a limiting factor is being alleviated by provision, under the Economic Co-operation Agreement between Britain and the United States, of the services of American technicians and scientific workers for various projects and investigations in Africa and the West Indies, such as the pilot survey for a link between the railway systems in East Africa and the Rhodesias. Further American aid is being given to expedite and increase the production of such 'deficiency materials' as kyanite, cobalt and bauxite, and assistance has been formally sought for twenty-nine projects involving a total expenditure of 7·6 million dollars. A leading American ecologist has arrived in the United Kingdom to work upon locust-control problems, and the temporary engagement of American workers to strengthen existing research organisations in several Colonies is foreshadowed.

The survey also gives a concise picture of the international collaboration proceeding in technical and other matters not only under the auspices of the United Nations but also directly between the Colonial Powers; the establishment by the Governments of Belgium, France, Portugal, Southern Rhodesia, the Union of South Africa and the United Kingdom of a Commission for Technical Co-operation in Africa south of the Sahara and co-operation in locust control are specially mentioned. Regional co-operation also continued satisfactorily, taking the form in Africa of discussions on technical matters and of the exchange of visits and information. The Caribbean Commission met twice during the year, and the participating governments re-affirmed their support of the Commission as an advisory body on regional, social and economic problems. The South Pacific Commission has established its permanent headquarters in Noumea, New Caledonia, and its programme of research provides for twenty-eight projects. In the same connexion, it may be noted that the Colonial Office, which on April 1, 1949, took over responsibility for the scientific sections of the Imperial Institute doing work in the Colonial sphere, continued to be engaged on the affairs of the West African Cacao Research Institute and the West African Institute for Trypanosomiasis Research. Legislation is at an advanced state to allow the establishment of the latter as a corporate body, and with the appointment of a new director of fisheries the development of the West African Fisheries Research Institute will be started again. A five-year programme of research and development, costing three million pounds, has been agreed for the Rubber Research Institute of Malaya, the British Rubber Producers' Research Association and the British Rubber Development Board.

Generally, it may be said that, although the constitutional developments recorded in the Survey, such as the proposals for a British Caribbean Federation, for a new constitution in the Gold Coast, with an Executive Council including eight African Ministers appointed from the legislature, and for a new Nigerian constitution are the most spectacular developments recorded in the survey, the impression is left that the pace of economic and social development is now reaching the limit when it will be determined by financial and social considerations and not as hitherto by the availability of materials or man-power. Equally it is clear that political factors are tending to set a pace incompatible with the provision of a firm social, economic or scientific basis for real advance.

This is well illustrated by two matters referred to in the review of economic development. An important experiment is being conducted in Nigeria to demonstrate that the use of artificial fertilizers is within the reach of the African peasant. In the first instance, a special staff will supply groundnut growers with fertilizers free of cost in a form which makes it simple for the peasant to apply a suitable dose as he sows the seed. The special staff will demonstrate a technique which should enable farmers to obtain good increases in yield by applying a fraction of the quantity of fertilizer required when it is applied by the traditional broadcast method. If successful, the technique will be extended to other crops. In the meantime, it is of special interest in view of the further light thrown on the failure of the East African groundnut scheme by the recent report from the Committee of Public Accounts, as well as by Mr. Alan Wood's book, "The Groundnut Affair". The experiments will doubtless be watched with interest by the Working Party appointed by the Overseas Food Corporation.

The second point is in regard to the virus diseases of cocoa known as swollen shoot. It is clear, according to this report, that remedial measures are not keeping pace with the spread of the disease in the Gold Coast, and the new Governor decided to ask the legislature for the re-imposition of compulsory powers in areas where the majority of the farmers are in favour of cutting out. Besides this, however, an agreement has been concluded with Pest Control, Ltd., whereby a team of three scientific workers provided by the Company are to be attached to the West African Cacao Research Institute to carry out a programme of research into the possible use of systemic insecticides in controlling the spread of swollen shoot disease.

At least three years must elapse before there can be any question of applying such control methods on a field scale, and accordingly, like the Nigerian experiment, this development emphasizes the difficulties that arise when political or economic factors are urging a pace of development quite incompatible with the scientific survey and examination which provide the firm basis for real advance. Even if the Survey suggests that the difficulties with regard to scientific and technical man-power are no longer quite so acute, no scientific man or professional man who reads this Survey can remain in any doubt as to the extent of the demand which the Colonial Territories must make for years to come on the universities and the professional associations of the country and on the Colonial Service for trained men and women, if only in training their own peoples and building up professional ideals and traditions in those territories. Nor can that be done without simultaneously a great expansion in secondary education in the Colonial territories to provide the technicians and teachers, and above all the educated middle class outside the Government service upon which the application of the new techniques and the stability of political and social life will largely depend. "The Colonial Territories, 1949–50" possibly underrates the gravity of certain political factors, notably the seriousness of the situation in Malaya and the deterioration of racial relations in Africa; but it sets most admirably in a larger context the work of the man of science described more fully in the reports on "Colonial Research". It should be read and pondered by all concerned with such work, and by those who reflect on the larger issues involved in the relations of Great Britain with its Colonial territories, our interdependence, political as well as economic, and our ability to inspire the young leaders which the Colonial universities will increasingly provide for their communities with a vision and faith equal to the demands of the modern world.

PRODUCTION OF ANTIBODIES

The Production of Antibodies

By Dr. F. M. Burnet and Dr. Frank Fenner. (Monograph of the Walter and Eliza Hall Institute, Melbourne.) Second edition. Pp. viii+142. (Melbourne and London: Macmillan and Co., Ltd., 1949.) 12*s*. 6*d*. net.

THE first edition of this essay, published in 1941, has long been rather hard to come by, and the appearance of a second is therefore proportionately more welcome. Since the publication of the first edition, and to a large extent because of it, antibodies have been interesting biologists more and more, in spite of the inroads of antibiotics into their therapeutic uses.

Dr. F. M. Burnet has not changed his ground. Antibody formation is thought to be the consequence of an *inherited* change in the pattern of synthesis of serum globulin in mesenchymal cells; that is, a change which endures through repeated fissions long after the physical disappearance of the agent which in the first place brought it about. (It makes no important difference to the theory what sort of cell actually makes antibodies, and the authors now give due weight to recent evidence incriminating the plasma cell and the lymphocyte, or its precursor.) According to Burnet's theory, therefore, antibody-formation is the outcome of an inherited cellular transformation. The 'chemical' theory, which in one form or another the authors couple with the names of Mudd, Haurowitz and Pauling, requires the continued presence of antigen during the entire term of antibody formation, the antigen being (crudely) a mould or template for distorting normal into antibody globulin. It is clearly a matter of the utmost technical difficulty to decide whether antibody formation outlives its stimulus or not, and the evidence one way or the other is at present quite inconclusive.

The incompatibility between the chemical and 'biological' theories turns solely on the question of whether or not a cellular transformation is entailed. As the authors point out, the mechanism envisaged by the chemical theory may well prove to be correct in principle, though it may not take place at such a late stage in the assembly line of globulin synthesis as is commonly thought. It is essential for Burnet's theory that the formation of antibodies is subsidized by a cytoplasmic self-reproducing system. Extracellular proteins like serum globulins are the reproductively inert by-products of the synthetic activity of an enzyme system which is undergoing continual replication in the cytoplasm. Antibody is serum globulin formed as the by-product of an enzyme system which, under the impress of antigen, has submitted to a slight inherited change that is in some important ways analogous to that responsible for the formation of adaptive enzymes in bacteria—an analogy supported since the publication of the first edition by Hinshelwood's interpretation of the adaptive process. The sort of molecular distortion envisaged by the chemical theory might be supposed to occur in the Burnet enzyme system itself rather than in the texture of its finished product—an idea which fits easily into the pattern of modern speculation about the nature of self-reproducing systems.

However, the authors would be the first to admit that much of the evidence they bring forward in support of their views is no more than suggestive. The existence of a short phase of exponential expansion of circulating antibody is poor evidence for the existence of a multiplicative antibody-forming system, though it is certainly consistent with such a possibility; and as evidence that antibody formation outlives its antigenic stimulus, the very long-drawn-out immunity that follows infection by some viruses is admittedly clouded by the possibility that a trace infection by virus does indeed persist. But to say this is to say the worst: this is a book which will stimulate or goad every immunologist into thinking afresh about old problems and coming to terms with new ones. Among the matter new to this edition is an ingenious and most stimulating commentary on the important and disturbing fact that embryos do not form antibodies, worked in with a theory of how antibody-forming cells come to distinguish native from foreign organic molecules. Another is the chapter on transplantation immunity, containing the suggestion that the response to the grafting of foreign homologous cells has something in common with the type of sensitivity provoked by tuberculin.

In summary, the immunologist needs no special inducement to read this essay, for he will do so anyway; but it is important that every biologist interested in the problems of cellular heredity and transformation should be aware of the rather direct bearing of antibody formation upon them.

A LIFETIME'S WORK ON TROPICAL MEDICINE

Happy Toil

Fifty-five Years of Tropical Medicine. By Major-General Sir Leonard Rogers. Pp. xvi+271+8 plates. (London: Frederick Muller, Ltd., 1950.) 18*s*. net.

A BOOK such as "Happy Toil" could only have been written by a Happy Warrior, and that in the person of Sir Leonard Rogers. It therefore follows that it supplies a record, breathing of that zest and burning enthusiasm which have emanated from his person throughout his long life. Sir Leonard's personality is engraven on every word, whether we pursue him on his bicycle scudding up and down impossible mountains or dodging elephants and leopards in his path. It is the same indomitable spirit which enabled him to flout conventions, to beard authority in its den, to discard his uniform whenever possible, and to refuse to budge one iota from his principles in order to placate his fellow men, but which finally enabled him to triumph over every conceivable obstacle.

This book has the spirit which led to discoveries of the first order, and in this category must be placed his researches on amœbiasis and that extraordinary reasoning which enabled him to place emetine treatment on a scientific basis. Next in order of importance must come his clarification of the life-history of Leishmania and the application of antimony therapy to the treatment of kala-azar. Although we may not all agree with his physiological tenets, nevertheless he introduced a new principle in the treatment of cholera. All the world knows of his struggles in the treatment of that hideous mutilating disease—leprosy. Throughout it all, Sir Leonard's super-optimism has carried him through, so that no one can deny that, as the result of his foundation of the British Empire Leprosy Relief Association, the lot of the leper has been revolutionized and the standard of treatment much improved.

Some, indeed, may cavil at the sweeping conclusions he has deduced from most intense, detailed and laborious studies in official blue books. In these he juggles with columns of figures on the incidence of cholera, pneumonia and smallpox in India. It might be suggested that sometimes the figures and methods of their assessment are not always reliable; but this has not deterred him from arriving at definite conclusions regarding the forecasting of epidemics.

There is no one who has possessed the drive, energy, enthusiasm and business capacity of Sir Leonard—or indeed one who could have extracted such large sums from the official and business circles of Calcutta. The School of Tropical Medicine there, together with the Carmichael Hospital for Tropical Diseases, will for ever stand as memorials to the memory of this great Englishman. That he is brave and determined has been shown on many occasions, in his handling of poisonous snakes, as well as in his successful battles against the anti-vivisectionists which graced the close of his career. There is a grand vein of optimism running through this book; but it could not be otherwise.

Sir Leonard would have you know that he has a profound divine faith and a deep belief in himself, his ancestry and his upbringing; he is also deeply conscious of his debt to science which he has repaid in generous gifts and in the value of the scientific work which he has so happily accomplished. He has penned a fine tribute to his wife, as is just, and his account of their courtship forms one of the most delightful interludes of his book. "No; she had not got cholera, but she had definitely got him."

PHILIP MANSON-BAHR

HEAT FOR DEGREE STUDENTS

A Textbook on Heat

By J. H. Awbery. Pp. x+302. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 15*s*. net.

MOST teachers of physics are aware of the importance of a sound knowledge of what is usually called classical physics. Classical physics, however, consists of the less spectacular and older branches, of which heat is one, and, in competition with the more attractive and rapidly advancing modern branches such as atomic physics or electronics, it nowadays receives inadequate treatment. This is due in no small part to the lack of suitable up-to-date text-books. However admirable Preston's "Heat" may be, it nevertheless does not attract the present-day undergraduate. The volume under review is a contribution in the right direction. It is written by a recognized authority on heat and an experienced research worker, and the original and stimulating manner in which the material is presented should prove acceptable to most readers. In place of the traditional detailed treatment of the thermal behaviour of substances and somewhat elaborate descriptions of experimental arrangements, the author has concentrated on fundamental principles and has tried to state clearly and precisely what are the essential features of particular investigations.

From a discussion of temperature and its measurement, the volume proceeds to the point where heat is found to be measurable, and from there to the relation between heat and energy. The first and second laws of thermodynamics, the properties of gases, the phase rule, the properties of solids, thermal expansion, and the properties of liquids with change of phase are then dealt with in that order. Three chapters on heat transfer follow, and after a chapter on statistical mechanics the book concludes with a discussion of the applications of thermodynamics to heat engines and to chemistry.

The standard is stated to be that of the ordinary degree; but it varies greatly from chapter to chapter. For example, the chapter on thermal expansion is most elementary, but those on statistical mechanics, conduction and convection, in particular, are more suitable for an advanced honours course. In some places there are unnecessarily long and involved mathematical discussions as though the reader is expected to have only limited mathematical ability; yet in other places second-order partial differential equations, Fourier series and the complex variable are introduced without much comment.

In the preface the author regrets that he has no teaching experience, and that because of this the book contains no examples. But this is by no means the only disappointing feature. All the illustrations are line diagrams, and several of them lack detail or are incomplete. Although the author stresses the importance of correct correlation of units, he fails in many places to follow his own advice. On some occasions the author's expressions are not well chosen. In its present form the work should be used for reference and with some caution, but after careful revision it should become a standard text-book for undergraduate use. S. WEINTROUB

JUVENILE CRIME AND ITS CAUSES

Delinquency and Human Nature

By D. H. Stott. Pp. viii+460. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

DURING the Second World War it was predicted by several psychologists that its termination would be followed, not by a diminution in the figures for juvenile delinquency, but by a further increase. Accordingly, in 1945 it was suggested to the Carnegie United Kingdom Trust that an intensive study of a group of adolescent offenders should be undertaken by an investigator who might be allowed to reside at an approved school as though he were an ordinary member of the staff. Mr. D. H. Stott has spent four years studying delinquents in this way; and the Trust has now published a full report of his observations and conclusions.

From a scientific point of view, one of the most interesting sections of Mr. Stott's report is his critical examination of the procedures that could be followed in researches of this type. He makes out a convincing case for using "a standard technique of investigation". In drawing up his own scheme he owes much, he says, to the advice of Prof. C. A. Mace on the logical nature of the issues involved and to Sir Cyril Burt for "schooling in method". Burt's method consisted in the combination of a case-study procedure, to elucidate causation, with a statistical procedure, to verify causal hypotheses. Mr. Stott, however, considers that the two modes of attack should be separated. He deplores the "insightless use of statistics" by recent psychiatric writers and urges that a systematic and intensive investigation of apparent causes should precede any attempt to collect numerical data on a wider scale. His present inquiry has therefore been limited to a detailed study of a hundred residents in a single approved school. This, however, he hopes will be supplemented later on by a more extensive survey to secure what he calls "statistical verification of sectional hypotheses".

A special merit of Mr. Stott's approach is that he treats crime as essentially a social and psychological problem, not as a psychiatric problem. Recent attempts to interpret delinquent behaviour in quasi-medical terms are, he maintains, largely due to the fact that the psychiatrists dealing with such cases generally have no basic knowledge of normal psychology, and consequently tend to envisage the problems that they encounter in terms of the pathological processes with which they are more familiar. "They cling to the ingenuous assumption, borrowed from their training in medicine, that what they regard as psychopathic states are due to some disease." He himself looks upon delinquency, not as a form of mental illness to be studied by the medical psychologist, but rather as an intelligible mode of reaction to an intolerable situation.

Nevertheless, he, too, seems more familiar with psychoanalytic studies of the abnormal than with the psychology of normal human nature. As a rule, he sets down his observations and his conclusions in the improvised and figurative phraseology of the psychiatrist rather than in the more rigorously defined terminology of the psychologist; and his conclusions about the causation of delinquency are admittedly based on analogies drawn from theories about neurotic disorder. Delinquent breakdown, he considers, is similar to nervous breakdown—to shell-shock, for example. There is first a rising tension set up by some long-standing situation which becomes at last almost unbearable. With his own cases this situation usually arose out of the unhappy emotional relations between the child and his parents, so that "the problem of delinquency is in great measure the problem of the unsatisfactory family". Then, when the child's nervous exhaustion has almost reached its tolerance-limit, a crisis factor—some spectacular event, such as a parental quarrel, a war-time shock or a narrow escape from a physical accident that leaves behind a chronic fear—seems to precipitate the actual lapse, which usually takes the form of a blind plunge into some wild or daring adventure. After all, therefore, so Mr. Stott goes on to suggest, a plausible case may be made out for treating the habitual offender "as a sick person".

However, the whole theory admittedly rests on what he terms his "very tentative hypothesis of nervous resources", supplemented by the psychoanalytic notion of avoidance-reactions. There can be little doubt that some delinquent careers start in this way: Mr. Stott's own examples, as well as the work of earlier investigators, provide convincing evidence to this effect. But what is far more questionable is his attempt to generalize this explanation in a manner which tacitly assumes that delinquency is a single specific condition due always to one and the same type of cause. The vast majority of the cases studied by Mr. Stott had been removed to an approved school just because their home situation was so unsatisfactory. How often would the same factors be found among delinquents who had not been removed on this account?

If we view the problem from the point of view of the biologist rather than from that of the pathologist, is it not possible, without invoking any new hypothesis about "nervous resources", to explain most of the early delinquencies of the young as the result of perfectly normal impulses? When a kitten steals meat from the larder, fights the cat next door or runs away and gets lost, we do not postulate a prolonged intolerable strain at home, with a crisis-factor to account for the final breakdown. The natural impulses of young children are of much the same general type; and, if uncorrected, may easily get fixed as habits. The problem rather is: What methods of moral training can be successfully adopted to forestall this uncivilized behaviour, and why do existing methods so often fail? If we may judge by published statistics, the after-histories of child guidance cases seem to show that, although a few delinquents of psychoneurotic type undoubtedly benefit by medical treatment, the majority respond far better to some form of moral re-education than to 'therapeutic treatment' in the psychiatric sense.

NEW PHOTOSENSITIVE PIGMENTS FROM THE TENCH RETINA

By Dr. H. J. A. DARTNALL
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THE wave-length of maximum light absorption for visual violet, the scotopic pigment possessed by fresh-water fishes, is given as 535–540 mμ by Kottgen and Abelsdorff[1]. This figure has been criticized by Wald[2] because it was obtained by subtracting the absorption spectrum of the bleached solution from that of the original solution. While agreeing with Kottgen and Abelsdorff's result for the 'difference' spectrum, Wald states that the true position of maximum absorption by visual violet is 522 ± 2 mμ.

These two figures are surprisingly far apart. In the case of visual purple the maximum of the difference spectrum is not perceptibly different from that of the unbleached solution, provided conditions are alkaline. Even in an acid solution, when the absorption of the bleached products advances well into the visible spectrum, the effect is quite small. It was accordingly thought that Wald's estimate had been 'pulled' too far into the blue by reason of the presence of yellow impurities and that the difference spectrum gave a closer approximation to the true figure. This view received apparent confirmation when an extract of roach (*Rutilus rutilus*) retinæ yielded a broad maximum at 522 mμ, and an extract of bleak (*Alburnus lucidus*) a well-defined maximum at 530 mμ, the maxima of the difference spectra being at 540 mμ and 533 mμ, respectively.

Recent experiments with the tench (*Tinca tinca*) have thrown an entirely new light on the problem, however.

The retinæ from five dark-adapted tench (5¾–6½ in.) were carefully removed and washed first in 0·6 per cent sodium chloride and then in McIlvaine's *p*H 4·6 buffer. They were then extracted three times with 1½ c.c. of aqueous 2 per cent digitonin. The extracts were bulked and made alkaline by the addition of 0·45 c.c. of *M* disodium hydrogen phosphate. The total weight of this solution (extract 1) was 4·99 gm. and its *p*H 7·7.

The absorption spectrum of extract 1 in the mid-visible range is shown in curve 1 of Fig. 1 (densities for 0·5 cm. optical path). There is a broad maximum at 470 mμ and an inflexion at about 530 mμ. On exposure to light, the solution bleached, first to orange-yellow then to lemon-yellow. The absorption of the fully bleached solution is given by curve II and the 'difference' spectrum by curve III. The 'difference' spectrum has two maxima (at 492 mμ and 512 mμ) and is totally unlike a visual violet 'difference' spectrum. If visual violet is present in this extract, then it is clear that, in addition, there must be photosensitive pigments absorbing maximally in the blue in order to account for such a difference spectrum.

As no more of this solution was available, a further extract (extract 2) was made from five dark-adapted tench (4½–5¾ in.). The previous procedures were repeated, except that the washing with *p*H 4·6 was substituted by one with *p*H 6·5 to minimize possible destruction of pigments by acid buffer, and that less digitonin was used in order to obtain a more concentrated solution. The total weight of this extract was 2·245 gm. and its *p*H 7·4.

The absorption spectrum of a portion of extract 2 was measured (curve I, Fig. 2). It was then exposed for two hours to light of wave-length 610 mμ (597–623 mμ) provided by a Hilger Barfit monochromator with 18 amp. D.C. strip filament lamp, an image of the telescope lens being formed on the front surface of the optical cell containing the solution. The absorption spectrum was then remeasured (curve II). The change in absorption (curve IV) as a result of this exposure is in good agreement with a typical 'difference' spectrum of visual violet. It should be noted, however, that the 'retinene$_2$' band, stated by Wald[2] as maximal at 405 mμ, has, in this case, two peaks, at 390 mμ and 416 mμ (indicated by the arrows in Fig. 2).

After the measurement of curve II, the solution was exposed to 'white' light from a metal filament lamp to complete the bleaching. The absorption spectrum was then measured once more (curve III, Fig. 2). The resulting further change in density is shown by curve V, which is the difference between curves II and III. Curve V has a well-defined maximum at 472 mμ and points of inflexion at 420 mμ on the blue side and at 540 mμ and 600 mμ on the red side. The inflexion at 540 mμ indicates that not all the 'visual violet' was removed by bleaching with the red light. If it is assumed that all the absorption of curve V at 620 mμ is due to the pigments responsible for curve IV, and a subtractive correction proportional to curve IV be made to curve V throughout the spectrum, curve VI is obtained. The effect of this operation is to remove largely the inflexions at 540 mμ and at 600 mμ and to accentuate the one at 420 mμ.

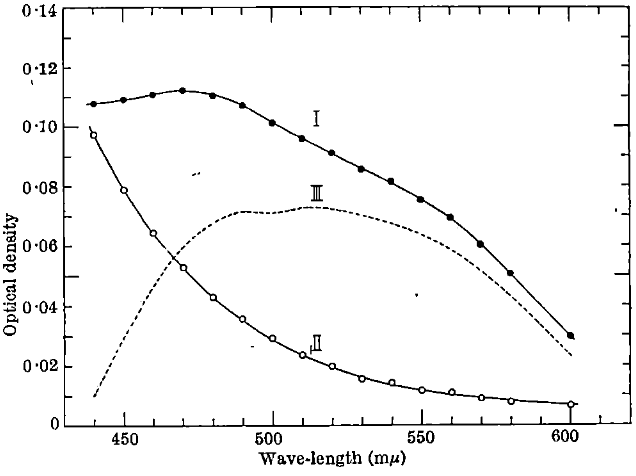

Fig. 1. First extract of tench retinæ. Curve I, the absorption spectrum of the extract. Curve II, the same after exposure to 'white' light. Curve III, the difference between curves I and II

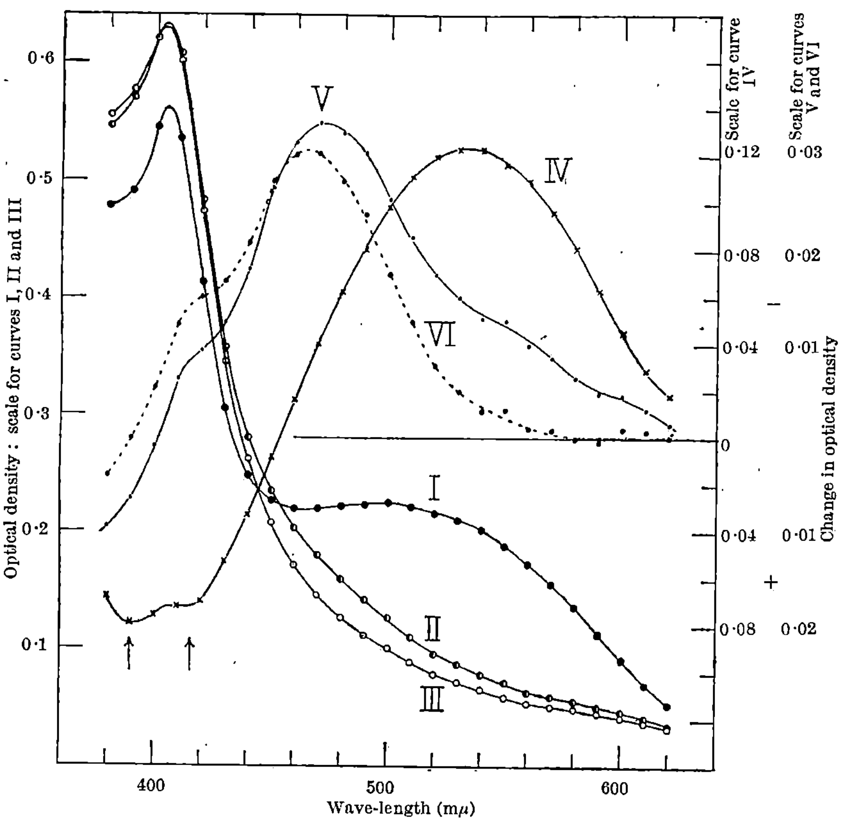

Fig. 2. Second extract of tench retinæ. Curve I, the absorption spectrum of the extract. Curve II, the same after two hours exposure to red light (λ = 610 mμ). Curve III, the same after further exposure to 'white' light. Curve IV, the difference between curves I and II, showing the difference spectrum of pigments bleached by the red light. Curve V, the difference between curves II and III, showing the difference spectrum of pigments insensitive to red light. Curve VI, see text. Note the differing scales for the density

The inference from these experiments is that in the present retinal extracts there exist, in addition to visual violet, at least two other photosensitive pigments.

In order to obtain more accurate information regarding the positions of the absorption maxima of these pigments, the following further experiments were carried out.

Another sample of extract 2 was exposed to the monochromatic light (λ = 610 mμ) for six hours. The absorption spectrum was then measured and found to be similar to that shown in curve II, Fig. 2. The solution was then exposed to light of wave-length 530 mμ (517–543 mμ) for an hour and three-quarters. The absorption spectrum was then again measured. The *change* is shown in Fig. 3 (full line), which clearly indicates that exposure to light of wave-length 530 mμ after an initial bleach with light of wave-length 610 mμ to remove 'visual violet' results in the disappearance of two pigments having absorption maxima at 407 mμ and 475 mμ respectively. Further bleachings of the solution with light of wave-length 500 mμ and finally with 'white' light confirmed the positions of the maxima and further showed, by reason of their varying relative heights, that they were, in fact, due to two pigments and not to a single pigment.

The portions above the 'zero' line of Fig. 3 are not, of course, the true absorption curves of the two pigments. In the first place, the full-line curve is a 'difference' spectrum, and hence the short wave-length 'arms' descend too steeply because of the rising absorption of the yellow products of bleaching. Secondly, the pigments have absorption maxima fairly close together, which will result in mutual distortion. Finally, the shape of the curve from 500 mμ onwards indicates the presence of visual violet even after six hours exposure to light of wave-length 610 mμ (cf. curves V and VI, Fig. 2). An approximate correction for this last effect may be made by assuming that all the absorption at 560 mμ is due to visual violet (curve IV, Fig. 2) and applying a proportional correction throughout the spectrum. When all the readings are corrected in this manner, the broken line of Fig. 3 is obtained. This correction has little effect on the positions of the two maxima.

It is noteworthy that the apparent positions of the maxima of the two new pigments have varied but little as their relative amounts have changed with selective bleaching. For this reason, it is considered that the wave-lengths quoted, namely, 407 mμ and 475 mμ, are within ± 5 mμ of the true positions.

During the measurement of all the absorption spectra described in this communication, the temperature of the pigment solutions was maintained thermostatically at 20·0 ± 0·1° C. From two to five determinations of the optical density were made at

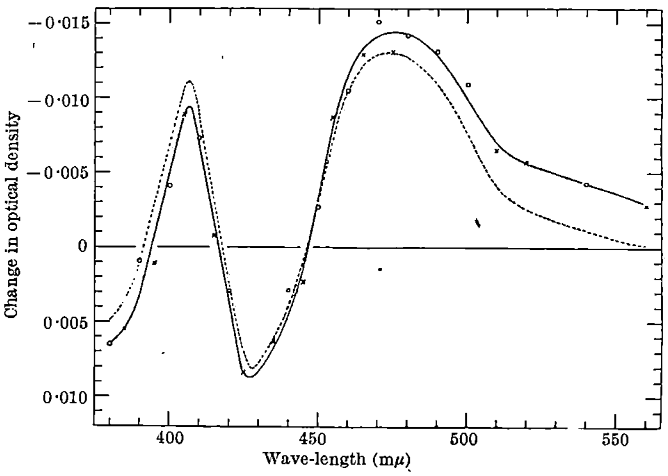

Fig. 3. Second extract of tench retinæ. The difference spectra of visual yellow 2 and visual red. The full-line curve shows the change in density on exposing the solution to green light (λ = 530 mμ) for $1\frac{3}{4}$ hr. after an initial bleach with red light (λ = 610 mμ) for six hours. The broken-line curve is the same after allowance for change of density due to visual violet

each wave-length and the average taken. Under these conditions the determinations of the mean optical density could be repeated to 0·0005.

Since the measurement of an absorption spectrum may take up to an hour, check measurements of the density at selected wave-lengths were made at intervals to determine if any changes were taking place in the solutions during the measurement. Alternatively, the method of 'spanning' was used. In Fig. 3 the observations marked with a circle were taken first, from left to right, that is, from short to long wave-lengths. The observations marked with a cross were then taken from right to left. In all the absorption spectra described in this communication, no changes outside the above-mentioned experimental error occurred during measurement.

The names proposed for the two new pigments, together with their wave-lengths of maximum absorption ($\lambda_{max.}$), are:

$\lambda_{max.}$ (mμ)	Proposed name
407 ± 5	Visual yellow 2
475 ± 5	Visual red

The principle adopted in choosing these names has been that employed for visual purple and visual violet, namely, to select the colour name *complementary* to that of the wave-length of maximum absorption. It would, perhaps, have been more desirable to indicate the *visual* functions appropriate to the pigments by naming them after the colours of their wave-lengths of maximum absorption; but the names visual purple and visual violet are too well established to warrant any change now. It is unfortunate that the term 'visual yellow' was once used for the yellow products of bleaching of visual purple; but happily it has now fallen into disuse in this connexion, having been replaced by such terms as 'indicator yellow' and 'retinene'.

Since the true absorption spectra of none of the pigments found in the tench retina is, as yet, known with any accuracy, it is not possible at this stage to form a precise idea of their relative densities in the retina. Visual violet is, of course, present in greatest density; but the amounts of visual yellow 2 and visual red are also considerable. Moreover, the red safe light (Ilford monochromatic filter 609 with a torch) used as a source of illumination during the extraction would cause considerable bleaching of any photosensitive pigments which may exist at the long wave-length end of the spectrum. The relatively large amounts of yellow material released into the buffer solution when washing the retinæ prior to extraction with digitonin, not to mention the large absorption in the blue in the digitonin extracts themselves (see Fig. 2), may be the bleached products of such pigments. The presence of these yellow substances may also account for the fact that the difference spectrum obtained by Bayliss, Lythgoe and Tansley[3] for the tench over their wave-length range of 480–650 mμ agrees with curve IV of Fig. 2 and not with curve III of Fig. 1. The yellow substances would act as an efficient internal filter and if, in addition, the bleaching light used were weak in the blue, it is possible that visual yellow 2 and visual red would remain largely unbleached.

In accordance with the quantum theory, it is preferable to consider the *frequency* of the light maximally absorbed by a pigment, rather than the more familiar wave-length. If this is done for the known visual pigments, it is at once apparent that the differences between the frequencies of maximum absorption ($\nu_{max.}$) for the different pigments are either equal to 0·35 × 10¹⁴ per second or to some simple multiple of this quantity. With this guide it is possible to draw up a table, the gaps in which probably correspond to visual pigments awaiting discovery.

Pigment	$\lambda_{max.}$ (mμ)	$\nu_{max.} \times 10^{-14}$ (per sec.)	$\Delta\nu_{max.} \times 10^{-14}$ (per sec.)
Visual yellow 2	407	7·366	3 × 0·351
—	(427)	(7·015)	
—	(450)	(6·664)	
Visual red	475	6·312	0·340
Visual purple	502	5·972	0·347
Visual violet	533	5·625	0·365
Iodopsin[4] (Visual blue)	570	5·260	
—	(609)	(4·925)	
—	(655)	(4·577)	

The table has been extended by the addition of two hypothetical pigments after visual blue (iodopsin) with maxima at 609 mμ and 655 mμ. Some evidence for the existence of the former was, in fact, obtained in the present solutions, as can be seen from Fig. 2 (curve V). Places for these additional pigments have been included in the table because Granit[5] has found maximal activity with the micro-electrode both at 610 mμ and at 640–650 mμ in the tench as well as at 530 mμ. Unfortunately, his studies with this fish in the light-adapted state were not carried below 500 mμ, so that the activity to be expected from the presence of visual yellow 2 and visual red has not been recorded. The maximum of visual yellow 2 (407 mμ) is beyond the range studied by Granit; but activity at 475 mμ (visual red) has frequently been observed by him in other animals[6].

It is interesting to note that maximal modulator or dominator activity has been recorded by Granit at or close to all the $\lambda_{max.}$ positions shown in the table except at 407 mμ.

[1] Kottgen, E., and Abelsdorff, G., *Z. Psych. u. Physiol. Sinnesorgane*, 12, 161 (1896).

[2] Wald, G., *Documenta Ophthalmologica*, 3, 94 (1949).

[3] Bayliss, L. E., Lythgoe, R. J., and Tansley, K., *Proc. Roy. Soc.*, B, 120, 95 (1936).

[4] Wald, G., *Nature*, 140, 545 (1937). Bliss, A. F., *J. Gen. Physiol.*, 29, 277 (1946).

[5] Granit, R., *Acta physiol. Scand.*, 2, 334 (1941).

[6] Granit, R., "Sensory Mechanisms of the Retina" (Oxford Univ. Press, 1947).

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT

TWO YEARS PROGRESS

A SECOND Press visit to the Atomic Energy Research Establishment at Harwell took place recently, when some of the progress achieved in the past two years was shown: this article is based on the information and demonstrations given on that occasion.

Since the previous visit (see *Nature*, 162, 317; 1948), the greater part of the Establishment's building programme has been completed, most of the experimental facilities have been installed and are working, and the scientific and technical staff has been built up nearly to its planned level. The primary commitment of the Establishment so far has been to provide information to the atomic energy production organisation, which is responsible for the piles and chemical separation plant for plutonium production at Windscale in Cumberland. This work has occupied the major part of Harwell's effort, and particularly of the chemistry, chemical engineering and metallurgy divisions. However, some progress has been made in design studies on experimental reactors for power production, and increasing effort is now being devoted to this work. A small team has rapidly expanded the production of radioactive isotopes, and in addition to users in Great Britain more than a hundred samples per month are exported to Europe and the British Commonwealth.

The following sections give short accounts of some aspects of the work at Harwell.

Chemical Engineering

The Chemical Engineering Division is concerned with most parts of the atomic energy programme, including extraction of uranium from its ores, the technology of materials used in reactors, and development on a pilot-plant scale of chemical separation methods for plutonium and other isotopes.

Uranium is very widely distributed throughout the world—the total quantity is estimated at about the same as copper and four times as much as lead—but there are few rich deposits. It is therefore necessary to develop economic methods of extracting uranium from low-grade ores, and to select the best method for use with a specific ore. For this work the mineral-dressing laboratory has been equipped with most of the modern types of small-scale mineral-dressing equipment. The laboratory has two main functions: first, to examine the ore to determine the manner in which the uranium is distributed in it, and to determine whether differences in the physical properties of the constituents of the ore are likely to be of value in concentrating the uranium into a smaller bulk; secondly, to study the various physical methods of mineral dressing on a sufficient scale to enable satisfactory techniques to be developed and appraised. In addition, it is also concerned with improving the understanding of the theoretical aspects of the processes involved and developing new methods.

Among reactor materials which are being studied are graphite, beryllium and beryllia, all of which may be used as moderators, and are therefore required free from impurities which absorb neutrons. Small-scale equipment has been installed for making graphite from coke and pitch and for extruding graphite shapes, so that new methods of producing samples with higher purity and better mechanical properties can be investigated. Beryllium is an extremely toxic material, and a special laboratory has been built for working with it and its compounds. In addition to its possible uses in a reactor, beryllia is a useful refractory, and crucibles and other beryllia ware are being made for use in the Establishment.

New methods of chemical separation being studied include ion exchange, solvent extraction and chemical exchange. These are required for a wide variety of problems: for the separation of plutonium from uranium metal which has been irradiated in the pile; for the separation of the radioactive fission products, for example, for the separation of radioiodine for hospital use; and for the separation of hafnium from zirconium in order to produce pure zirconium metal for new reactors. The object of these studies is not only to prove the processes involved and produce small quantities of materials for further experiments, but also to improve design methods in the operations involved.

Chemistry

The first wing of the new radiochemistry laboratory was completed last summer, and since that time the laboratory has come into full occupation and about 90 per cent of its facilities are installed and working. The most important work carried out in the laboratory is research on methods of separating plutonium and fission products from uranium metal that has been irradiated in a pile, and the chemistry and chemical engineering divisions have made pilot-plant studies on the method which will be used in the full-scale production plant.

Certain special laboratories are equipped for extraction of plutonium from uranium rods with an activity of the order of 100 curies (that is, equivalent to 100 gm. of radium). For work with this amount of activity, laboratory equipment has to be shielded by about 4 in. of lead, built up from interlocking bricks, and materials must be manipulated behind the shield by remote control.

While a large part of the chemical effort is concerned with problems related to the technology of plutonium production, the chemical problems associated with piles and reactors have not been neglected. The effect of radiation on the chemical reactivity of pile materials, for example, has received attention, a typical example being the system formed by graphite and air coolant. The pile is also being used for more general investigations such as a study of the chemical changes occurring in certain organic substances when exposed to radiation and various radiochemical studies. One useful application is the method of radioactivation analysis. In this method, the sample to be analysed is irradiated in the pile and, after removal, the radiation from new isotopes which have been formed is observed. In suitable cases, depending on the nuclear properties of the substances involved, very small amounts of impurities can be detected in this way.

Metallurgy

The work of the Metallurgy Division ranges from fundamental research studies into solid-state phenomena to technological development of materials and processes of particular interest to atomic energy, such as plutonium, uranium and beryllium, and methods of fabricating them in the desired form.

Among the basic researches which are being undertaken are diffusion in metals, deformation by twinning, heavy-element alloy theory and effect of irradiation on solids. In the technological field a new method has been developed of producing uranium metal much more economically than was possible by existing techniques, and new designs have been produced of uranium rods cased in aluminium which will withstand higher operating temperatures.

A systematic study is being made of the properties of uranium alloys, partly in the hope of finding alloys with better chemical, physical and mechanical properties than the pure metal, and partly to increase theoretical knowledge of the principles of alloy formation, so that alloy behaviour can be predicted more accurately than is at present possible. For this work an argon-arc furnace has been developed in

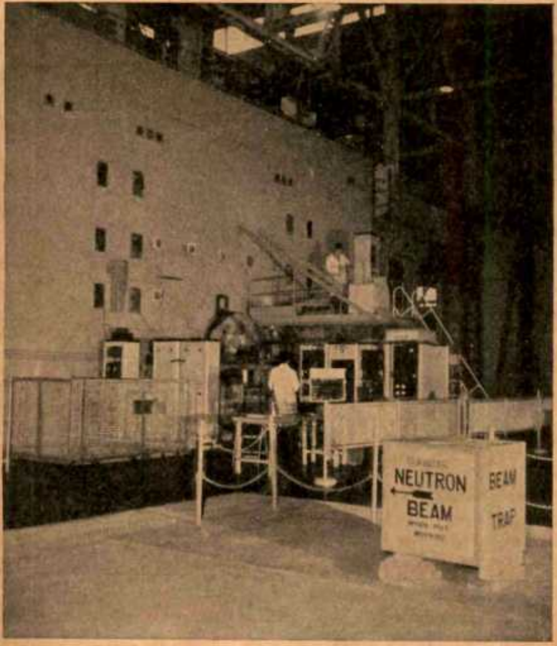

Fig. 1. BEPO. Experimental face of the pile. The apparatus near the face includes a neutron spectrometer and a mechanical velocity selector. There is other experimental equipment on top of the pile. *Crown copyright reserved*

which the most refractory metals can be melted. The metals are melted without using a containing crucible, and this feature, together with the inert atmosphere, allows specimens to be prepared at very high temperatures without contamination.

As part of the study of the effect of pile radiation on the physical properties of metals, an air-flow extensometer has been made which measures small strains (less than 10^{-6}) in a sample exposed to radiation in a pile. In these conditions only remote methods of measurement are possible, as conventional methods might be disturbed by the pile radiation. The principle of the method depends on measuring the air flow between two parallel plates attached to the specimen. The 'impedance' to air flow of the plates is then compared with a standard in an air analogue of an electrical Wheatstone bridge circuit.

BEPO

BEPO, the larger of the two piles at Harwell, started up for the first time almost exactly two years ago—on July 3, 1948. The next few months were spent in measurement of the characteristics of the pile, and tests and calibration of associated equipment; the pile came into full use in early 1949, and the production of radioisotopes began in it in February of that year. Since that time BEPO (Fig. 1) has been in almost continuous operation.

Apart from the production of radioisotopes, the pile is being used for experiments in nuclear physics and radiation chemistry, and on the properties of materials of importance to the reactor programme. The work of the chemists on reactions occurring inside a pile has already been mentioned. It is also necessary to study the effects of pile radiation on the mechanical, electrical and thermal properties of possible reactor materials, and the results of some of this work are of interest to the solid-state physicist.

For nuclear physics experiments with the pile, the auxiliary equipment installed includes a mechanical neutron velocity selector and two crystal neutron spectrometers. Most of the work in this field is concerned with the nuclear properties of reactor materials, including nuclear fuels, and investigation of nuclear reactions for isotope production; but some fundamental research has also been carried out, including a search for the di-neutron.

Production of Power from Nuclear Energy

As a result of design studies and two years experience in the operation of the Harwell piles, a suggested programme of construction of experimental reactors for the production of useful power has been drawn up, and this programme is now being considered by the Government. The next step will be feasibility and further design studies on these reactors, in order to find out whether they are practicable, and to make some estimate of their cost: this may take perhaps a year in one case and two years in another. Then, provided approval is given for a building programme, it will take another three years to complete and gain some experience in the operation of the first machines. Until this stage is reached, it will be impossible to make reliable predictions about the economics of power production.

The main problems in this work are: first, to find economical methods of extracting uranium from low-grade ores, and as has been mentioned the Chemical Engineering Division is working on this problem; second, to develop nuclear reactors which will burn a much higher proportion of the initial charge of uranium metal than will existing reactors; and third, to find suitable materials which will withstand the higher temperatures necessary for economic use of the heat produced in the reactor.

Nearly all the facilities required for studying these problems have been completed, and some progress has been made. Two nuclear accelerators, the Van de Graaff generator and the linear accelerator, have come into use, and are beginning to provide the information on nuclear constants which is an essential foundation for the programme. The Metallurgy Division is studying possible new reactor materials, and encouraging progress has been made in the production of beryllium shapes. Another potentially useful metal is zirconium, but this is difficult to prepare in a sufficiently pure state: the Chemistry Division has worked out a promising method for doing this, which is capable of development on a production scale. Liquid metals may be used in new reactors, and the heat transfer problems at the very high transfer rates that would be required are being studied by the Engineering Division. The Engineering and Chemical Engineering Divisions are also studying the problems of circulating liquid metals in closed circuits.

Production and Application of Radioactive Isotopes

A small but intense effort is being devoted to making artificial radioactive isotopes, and production now exceeds five hundred samples per month, a figure at least comparable with production in the United States. The use of this valuable new research tool is increasing rapidly, particularly in medical and university laboratories, and in recent months there has also been some increase in industrial use. The

Isotope Division at Harwell maintains an advisory service to assist potential new users, and also showed some typical applications in the British Industries Fair.

Two applications that are being widely used are the measurement of the thickness of thin films by the attenuation of rays from a β-emitter, and the dispersion of static electricity. In the case of the former, several instruments made commercially are already on the market. Another promising application is the use of γ-emitters for industrial radiography, and several isotopes for this purpose are already available in standardized source sizes. The present aim is to find a range of sources covering the energy region from 200 KeV. to about 1 MeV., which would be suitable for radiographs of steels and light alloys from ¼ in. up to 6 in. thick. Cobalt-60, with γ-ray energies of 1·1 and 1·3 MeV., tantalum-182 with an average of 1·125 MeV. and iridium-192 with an average of 0·5 MeV. all appear suitable, and other isotopes are being investigated.

It is sometimes forgotten that many of the artificially produced radioisotopes require chemical processing after they are taken out of the pile. Because of the short half-life of the most widely used isotopes, much of this processing has to be done at Harwell, including a production of phosphorus-32, iodine-131 and gold-198, each of the order of 1 curie per week; one suite in the new radiochemical laboratory is used almost entirely for this work.

Chemical processing of longer-lived isotopes, and syntheses of compounds with 'labelled' atoms, particularly carbon-14, are carried out at the Radiochemical Centre at Amersham, which became an outstation of the Establishment last April.

Particle Accelerators

The newest particle accelerator at Harwell, completed earlier this year, is a 4-MeV. linear accelerator, similar to the Malvern accelerator previously described[1]. It will be used principally for measuring the neutron cross-sections of reactor materials by the time of flight method. The accelerator produces pulses of electrons lasting 2 microseconds, with a beam current in the pulse of about 120 milliamperes. The electron beam strikes a heavy-metal target, so producing intense pulses of γ-rays. In this machine, the γ-rays are used to irradiate a beryllium target, which gives the neutrons required for experimental work.

Compared with other accelerators giving a similar output, the linear accelerator is both compact and cheap: because of these factors it is very suitable for deep X-ray therapy in hospitals, and some similar machines are to be built for this purpose.

The 175-MeV. synchro-cyclotron (Fig. 2), which started up last December[2], has continued to work remarkably well and is now available full-time for experimental purposes. Some interesting results have already been obtained with it, and these were the subject of a recent communication in *Nature*[3].

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[1] *Nature*, **162**, 859 (1948).

[2] *Nature*, **165**, 90 (1950).

[3] *Nature*, **165**, 967 (1950).

FOURTH WORLD POWER CONFERENCE

THE World Power Conference, founded in 1924, has held plenary meetings in 1924 (London), 1930 (Berlin) and 1936 (Washington). Although sectional meetings have been held in intermediate years, including one at The Hague in 1947 on the subject of fuel economy, the Second World War caused a gap in plenary meetings after the Washington meeting extending until this year. The Fourth World Power Conference was held in London during July 10–15, under the patronage of Princess Elizabeth and the Duke of Edinburgh. The theme was "World Energy Resources and the Production of Power". The Conference, which was attended by representatives of more than forty nations, was opened by its president, Sir Harold Hartley, in the presence of a distinguished company, including representatives of the Governments of many of the nations represented. For discussion within four working days, the gathering had before it 155 papers and 19 general reports, each of which dealt with one of the sections into which the papers were divided.

There is anxiety throughout the world concerning reserves of energy. The demand for electricity has increased of late years at an exponential rate, and if the demand for coal, oil and gas has more nearly followed a straight-line law, the slope of the line has

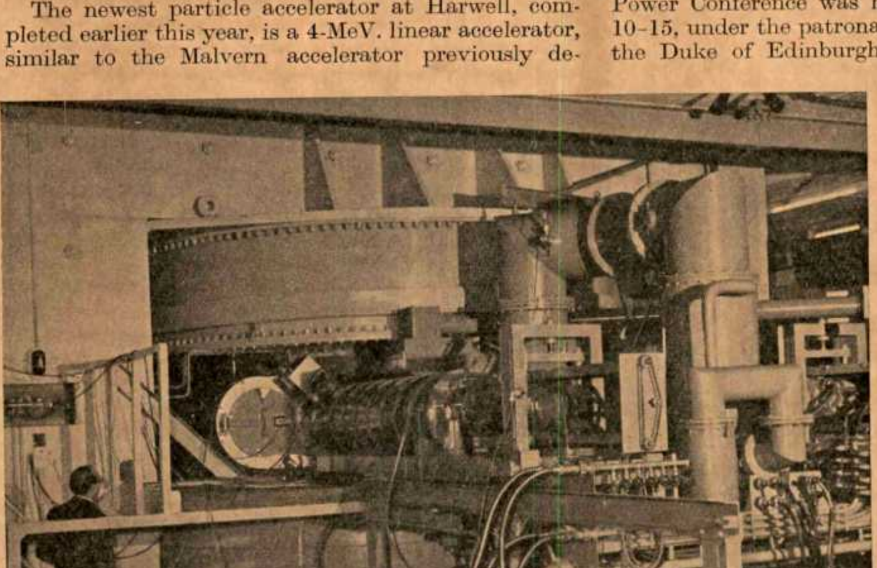

Fig. 2. 175-MeV. synchro-cyclotron at Harwell. The accelerating voltage is fed into this side of the machine from a radio-frequency transmitter. *Crown copyright reserved*

been such as to cause concern among individual nations as to when their own supplies of fossil fuels will become exhausted, and to the world in general as to possible sources of energy when there is no more coal or oil. Our present civilization is built on harnessing artificial sources of power to human needs; the greater the productivity, the greater the consumption of coal and oil. The statement was made that if in Britain the same amount of power was used per head of population as in the United States, the whole of the country's present coal output would be needed to generate the electricity required.

In consequence of this position, there is the greatest activity all over the world to eke out coal reserves by using other sources of energy. Many nations, among whom are the Norwegians, the Swedes, the Canadians, the Finns, the Poles, the Austrians, the Portuguese, the French, the Swiss, and even the Americans, are developing their indigenous sources of water-power; in many of these lands this meets most of the energy requirements. Other ideas are finding practical expression. There is a project at Abidjan on the Ivory Coast for using the potential thermal energy of sea-water existing by reason of the vertical temperature gradient of 68° F. or more over a depth of 1,640 ft. in tropical seas; a boiler heated by water at a temperature of 82° F. would supply a turbine with steam at a corresponding pressure exhausting into a condenser cooled by water at 46° F. A unique hydro-electric scheme is proposed in North Africa whereby the waters of the Mediterranean would be admitted to the Qattara Depression, providing some 300 MW. of hydro-electric capacity, the incoming water being disposed of by natural evaporation from the salt lake formed in the Depression. At Lardarello, in Italy, there is what the general reporter described as "a unique and epic achievement in engineering history" in which natural steam at 15–18 atm. and 285–420° F. is obtained, mixed with gases, from underground molten volcanic magma by putting down boreholes, up to 10,000 ft. in depth, capping them like an oil gusher when the initial eruption has quietened somewhat, and expanding the steam through turbines; since 1949, power production from this source has been at the rate of more than 1,000 million kWh. a year, and makes an important contribution to satisfying Italy's energy requirements. Wind-power and atomic energy are also under investigation. The planned international development of rivers by mutual agreement for the advantage of all nations through whose territory they flow was generally approved, the uses including power, irrigation, fishing and transport. Fuel economy is being scientifically pursued by all industrial nations; but one important source of waste appears to be virtually untouched—avoidance of loss of coal underground. The coal lost in mining bituminous coal in the United States, as an example, is generally cited as 34·7 per cent, a figure published by the U.S. Bureau of Mines twenty-five years ago, with the comment that more than half these losses were avoidable; present opinion is that this loss has since risen, perhaps to 50 per cent.

In 1924, British coal reserves were estimated as 137,166 million metric tons, which on an output of 200 million tons a year seemed comfortably sufficient for 685 years. The Regional Survey Committee of the Ministry of Fuel and Power in 1945 arrived at a total reserve of 44,714 million metric tons, plus some explored but probable additional reserves. If this estimate does not allow for mining losses, Great Britain's resources may be sufficient for not much longer than 150 years. Hydro-electric resources of the British Isles can provide only a modest proportion of the total energy requirements of the population. In 1948 the output of hydro stations under the British Electricity Authority was 517 million kWh. It is believed that a total of about 12,000 million kWh. could be generated in Scotland and a further 2,365 million kWh. from a Severn barrage. A total of 20,000 million kWh. appears to be the limit in the present state of knowledge. This is less than half the electricity distributed through the public supply in Great Britain in the year ending March 31, 1949, and thus corresponds to about one-tenth of the country's coal consumption. The British Electrical and Allied Industries Research Association and the North of Scotland Hydro-Electric Board have arranged for the erection of a 100-kW. wind-driven generator in the Orkneys as a pilot plant.

The oil industry provides a striking example of conservation of existing resources and of discovery of new reserves more than keeping pace even with present-day leaping requirements. Technical skill has overcome the challenge of maintaining supplies at a level that has met unprecedented demands. The depth from which oil is obtained has increased from 2,314 metres in 1925 to 6,270 metres. The submerged sea areas bordering the North American continent represent an "assured source of large quantities of petroleum". Drilling and production practice has been greatly improved. One most important advance has been the development of reservoir engineering with the object of so guiding the exploitation and operation of oil reservoirs as to achieve maximum recovery at minimum cost.

The production of energy from nuclear fission is exercising keen minds, at great cost, in many lands. The method visualized is the transfer of heat from a nuclear reactor through a suitable medium (helium under pressure being favoured at present) to the boiler unit of a conventional power-generating system. Nuclear reactors must be devised which will develop heat at a temperature high enough to produce high thermodynamic efficiencies; the reactors must utilize nuclear fuel efficiently; the reactor life must be long enough to keep interest and depreciation charges to a reasonable level; overall operating costs, including costs of providing and processing nuclear fuel, must be comparable with costs of power stations of conventional design. Among the more important scientific factors is the need to 'breed' more secondary nuclear fuel within the pile than primary fuel consumed; a difference of opinion was observed at the conference on the extent to which this can be done at present. Engineers asked pertinent questions on the stability of constructional materials under pile conditions, since the whole of the plant must be within a protective casing. Existing power plant requires frequent inspection and maintenance; it is asked how the problems of lubrication and maintenance can be overcome under atomic-pile conditions, where both circulating system and prime mover are inaccessible. Reactors under construction in the United States and Britain are expected to provide information on the many scientific and engineering problems involved; but an American author confessed that the technical problems in power generation from nuclear fission "are proving to be more difficult than was expected three years ago".

The sections dealing with the preparation of solid fuels discussed coals, sub-bituminous coals and peat, and coke. Modern mechanical coal mining is bringing to the surface material containing a greater proportion of dirt and a larger quantity of fines. The use of water underground for dust suppression seems likely to cause the total disappearance of dry-cleaning systems. New wet-washing methods, such as dense-medium processes and froth-flotation, combined with older established methods now enable any size of coal to be cleaned; the immediate problem in many countries is to erect suitable and sufficient coal-cleaning plant at a reasonable cost and in reasonable time. How far fines should be cleaned and how far they should be used in the uncleaned state for powdered-fuel firing remains a difficult economic question. The tendency in Britain is to erect large central washeries. Coal cleaning is becoming a specialist subject. The National Coal Board has adopted a practical classification of British coals based on rank, yield of volatile matter and coking property, and has brought into use the standard size grading of the former British Colliery Owners' Research Association, in which only seven sizes above ⅛ in. are recognized for marketing purposes. There is a difference of opinion between nations possessing peat deposits as to whether the winning of peat is economical; the utilization of peat is under examination in several countries. Brown coals and lignites, which were extensively developed in Germany, are now being used for boiler firing in Australia, Czechoslovakia, Yugoslavia and elsewhere, and efforts are being made to dry and briquette it economically or to carbonize it.

All nations possessing coking coals are finding that their reserves of good coking coals are running low. Research is being undertaken on the use of the poorer coking coals for making blast furnace coke. Fine grinding of the coals, blending of coking with poorly coking or non-coking coals or with semi-coke, and two-stage processes often involving pre-carbonization followed by briquetting and re-carbonization are favoured. Economics, including cost of transport and manufacturing costs, dictate which, if any, of these processes can be used, even when they are technically sound. The possibility is envisaged of devising a low-cost method of iron-making that does not require hard coke.

Advances in the petroleum industry have been due to increasing demand for gasoline both in quantity and quality. Catalytic cracking is replacing thermal processing. The low efficiency (6 per cent) of gasoline used for transportation has led to increased engine compression ratio, which in turn necessitates gasoline of much higher octane number—an expensive matter—as an alternative to which manufacturers are endeavouring to improve the efficiency of the use of gasoline, for example, by a small super-charged engine, together with after-cooling, an exhaust gas turbine, and an automatic transmission. The application of chemical synthesis is a feature of the modern petroleum industry, including polymerization, alkylation, isomerization, superfractionation, catalytic cracking and hydro-reforming. Synthetic production of liquid fuels from coal, brown coal, etc., is being intensively studied; but these processes are only likely to be used industrially when supplies of natural oil become less than demand. The view was expressed that ultimately coal would be used solely as the raw material for the manufacture of oil for the internal combustion engine, other sources of energy being developed to replace coal for its present uses.

Natural gas—once largely wasted—is now making an increasingly large contribution to energy requirements both in America and Europe. It is used as fuel for industrial and domestic purposes, in the compressed state as a substitute for gasoline, as raw material for manufacture of chemical products and of synthesis gas for synthetic liquid fuel production, and as a source of hydrogen for synthetic ammonia manufacture. Interest is being taken in the recovery of methane from coal seams, partly to reduce the fire-damp concentration in gassy mines.

There is increasing use in many countries of the lower grades of fuel in large steam-raising units; this leads to problems of boiler availability and size, of ash and grit disposal, to increased capital cost and possible reduced efficiency. Pulverized fuel firing is favoured, largely because of its flexibility, for larger boilers; but it has limitations with low-volatile coals. High steam pressures and temperatures, for example, up to 2,133 lb./sq. in. and 968° F., are ranked high among means of securing greater economy; in Britain, 81 per cent of the new plant is designed for two standard conditions: 600 lb./sq. in., 850° F. and 900 lb./sq. in., 900° F.; some new British plant will operate between 1,235 lb./sq. in., 825° F. and 1,500 lb./sq. in., 1,050° F. The Americans have plants running with steam at pressures of 1,800 and 2,000 lb./sq. in. and many plants are designed for steam at 1,050° F. These conditions are permitted by the use of newer steels, mainly ferritic, with greater high-temperature strength. There is a tendency to use larger turbo-generators and larger boilers; in Britain, many 60-MW. and a few 100-MW. machines are under construction. In the United States, the trend towards the single boiler-turbine combination has involved steaming capacities up to 1,370,000 lb./hr. The higher capital charges involved in burning low-grade fuels have been mitigated by more suitable design supplemented by better methods of on-load cleaning. The cyclone furnace has increased in popularity when the ash-fusion temperature of the fuel has been suitable. Spreader stokers are increasingly used for lower capacities. The natural-circulation boiler seems to hold its own over forced-circulation and other competitors. Greater use is made of re-heat. Series of papers discussed the design of turbines and auxiliaries, and the use of fuels other than coal for steam-raising, for example, wood, brown coal, peat, town refuse and vegetable waste.

The wide variety of uses to which the gas turbine is put were reflected in the interest aroused by the discussion. Its future utilization depends on its ability to burn cheap fuel, and in all countries the development is towards using as gas turbine fuel coal or residual oil, and, in Britain, peat. Deleterious gaseous matter may cause difficulties, and it is not yet certain whether the largest size of particle which can be permitted to reach the turbine blades is 10 μ or as high as 20 μ. Exhaust gases from high-temperature processes can be used for power generation, and the turbine can supply as exhaust low-temperature gases for drying, or pre-heated air for furnaces. The open cycle is generally adopted; but many believe that more emphasis should be put on the closed cycle. A second noticeable feature is the almost universal adoption of the axial-flow compressor. The gas turbine is clearly still in a comparatively early stage in its development; we cannot yet design a machine to run successfully and consistently on any given fuel.

G. E. FOXWELL

NEWS and VIEWS

Veterinary Medicine at Cambridge: Prof. L. P. Pugh

THE appointment of Leslie P. Pugh to the newly established professorship of veterinary clinical studies in the University of Cambridge marks a further important development in the building up of the School of Veterinary Medicine at Cambridge. Prof. Pugh graduated from the Royal Veterinary College in 1917 and took his B.Sc. in the University of London in the same year. Since the end of the First World War he has been in practice at Sevenoaks. Prof. Pugh obtained the fellowship of the Royal College of Veterinary Surgeons for a thesis on bovine sterility in 1923. He was a pioneer in work on sterility of cows, using methods that have only in recent years been generally adopted. Later, in collaboration with laboratory workers, Prof. Pugh made important contributions to the study of leptospinal jaundice in dogs, he being the first to recognize this disease in dogs in the United Kingdom. More recently his interest has been directed mainly to the complex problem of virus infections of the central nervous system of dogs. Prof. Pugh, who is regarded by his professional colleagues as an outstanding clinician, has managed to carry on clinical research at the same time as conducting a very successful practice. His new appointment will give him opportunities of pursuing his research with greater facilities as well as passing on his knowledge and skill to others. He takes up his new appointment in January 1951.

Polarographic Institute, Prague

ON June 20 the Czechoslovak Government founded by decree a number of central research institutes, covering mathematical, physical, astronomical, chemical, geological and biological studies, which will come under the State Planning Office. Among these new bodies is the Polarographic Institute, the director of which is Prof. J. Heyrovský, who is now leaving the Ministry of Education and the Physicochemical Institute in the Faculty of Sciences, Charles University, Prague. Prof. Heyrovský remains an honorary professor in the University and continues to lecture there. The aim of the Polarographic Institute is to foster polarographic methods for pure and applied science, to concentrate all documentation and bibliography in its library and to promote polarography by practical courses and lectures. There is room for eighteen scientific staff and seven administrative staff; in addition, visiting students are welcomed. The Institute is provisionally in a flat containing ten rooms in a building where research on metals is concentrated (Prague II, Opletalova 5); but larger accommodation is being sought. The present staff numbers fourteen, including the director and Dr. J. V. Novák (vice-director), known from his numerous papers on polarography.

School of Gas Turbine Technology

POWER Jets (Research and Development), Ltd., announce that the School of Gas Turbine Technology is re-opening at Farnborough Place, Farnborough, in October. Operated at first by the National Gas Turbine Establishment, the School was taken over in 1948 by Power Jets (Research and Development), Ltd., a nationally owned company, which is responsible for the exploitation of a large number of British patents covering gas turbine technology and design. The School has been moved, because of expansion, from its old premises at Lutterworth. Founded in 1944 to instruct Dominions' Air Force personnel in aircraft jet engines, the School now gives theoretical and practical instruction in the use of gas turbines in high-speed aeroplanes, locomotives, road vehicles, ships, power stations, process power and other industrial applications. There will be four different types of courses, one of which is an international course designed specially for overseas engineers. Particulars of courses can be obtained from the Principal, School of Gas Turbine Technology, Farnborough Place, Farnborough, Hants.

Display of Early Herbals in Edinburgh

THERE have been placed on view in the Upper Library Hall of the University of Edinburgh, primarily to illustrate a lecture to the history of medicine class, but also to interest a wider audience, a number of early herbals, pharmacopœias and works on domestic medicine from the University Library. In the collection are two copies of that pioneer of herbals, the "Hortus Sanitatis", printed at Strassbourg in 1497, crudely illustrated, but widely used in its day. A much higher standard of draughtsmanship is apparent in the lovely "Herbarium Vivæ Eicones", first published by Otho Brunfels in 1530, and it was maintained in the later works of Leonhard Fuchs, who gave his name to the *Fuchsia*, and of Lobelius, from whom *Lobelia* is named. In 1569, Monardes of Seville described many new vegetable remedies from America; his book contains the first printed illustration of the tobacco plant. William Turner, dean of Wells, is often regarded as the 'father' of English botany. The herbal which Turner dedicated to Queen Elizabeth was followed by the works of John Gerard, who grew potatoes in his garden in Holborn, and of John Parkinson, who entitled his book "Paradisi in sole" (park in the sun), and who was perhaps the last of the great English herbal writers. There is also on view a handsome copy of Elizabeth Blackwell's "Herbarium", in three volumes, containing a curious drawing of the Scythian Lamb, half animal, half vegetable. Among the pharmacopœias is the unique copy of the first edition (1699) of the Pharmacopœia of the Royal College of Physicians of Edinburgh, kindly lent by the College, while domestic medicine is represented by several Gaelic manuscripts, and by one of the first printed books of this class, entitled "The Poor Man's Physician, or the Receits of the famous John Moncrief of Tippermalloch", dated 1712. Copies of those very popular guides, John Wesley's "Primitive Physic" (1747) and William Buchan's "Domestic Medicine" (1769), are part of the exhibition, which has been described and annotated in a booklet prepared by Dr. Douglas Guthrie, with the collaboration of Dr. Sharp, Dr. Corson and Mr. Finlayson, while the photostencil illustrations are the work of Mr. R. J. Mackay.

Anthropology and Genetics

THE fifteenth symposium of the Long Island Biological Association on Quantitative Biology was held at the Biological Laboratory, Cold Spring Harbor, New York, during June 9–17. Each year a biological subject is chosen which is susceptible of quantitative treatment, and speakers are invited who have investigated the subject from as many different angles as possible. The subject of this year's papers and discussions was "The Origin and Evolution of Man". The programme was planned by Dr. M. Demerec, director of the Laboratory, in consultation with Prof. Th. Dobzhansky and Prof. S. L. Washburn. The first day was devoted to population genetics; and then followed a consideration of man's origin and evolution from the morphological point of view. The next subject was the genetical analysis of racial traits, such as blood groups and other normal and pathological human characters. The concept of race and racial types was next considered, and then the question of individual constitution and the correlation of the morphological type of the individual with physiological and psychological characters. The last day was devoted to a general summing-up and a consideration of the possibilities of future research. One suggested proposal made earlier in the symposium by Prof. S. L. Washburn was the institution of a science of experimental anthropology, based upon the study of lower primates. As an example of what might be achieved, he instanced the effect of the ablation of muscles in preventing the development of major external features of the skull. The main purpose of this symposium was to bring together anthropologists and geneticists, and this it achieved most happily. The effect of this 'cross-pollination' remains to be seen; but it may well represent a notable landmark in the science of anthropology.

Planning and Production Costs in Great Britain

In a brochure issued by Political and Economic Planning (16 Queen Anne's Gate, London, S.W.1) entitled "Economic Policy: a Discussion of Planning Techniques", it is pointed out that for many years government after government in Great Britain has been playing an increasing part in economic affairs. The first post-war government found ready to hand a machine of control left over from the War. There were great post-war demands for capital and consumer goods, limited resources of equipment, labour and materials to meet the demands, and the consequent danger of severe inflation; the mechanism of world trade had been thrown off its balance, and it was necessary to change over from war to peace production. All these problems demanded policies not fundamentally different from those of war. Controls were therefore preserved; but, as conditions improved, they were gradually relaxed and in part abandoned. The main tasks of planning are now in connexion with costs. If overseas markets are to be held, costs must be reduced; if internal stability is to be maintained, they must be reduced without deflation. The volume of industrial production has not risen quite enough to cover both the increased consumption and increased capital expenditure of the past five years—in other words, production costs are too high. The crucial problem is how to get the two sides of the equation to balance. It is a problem involving more than monetary policy; it is also a psychological problem and one of organisation.

Atmospheric Pollution and Smoke Abatement

The National Smoke Abatement Society, which was founded in 1929, 'comes of age' this year, and its Spring Number (No. 73; 1950) is set out to direct attention to the achievements in twenty-one years. After a modest growth in ten years, the Society expanded rapidly during the period of the Second World War. The Spring Number contains interesting articles on current fuel practice in Great Britain and in the United States; probably the most interesting are those dealing with the influence of atmospheric pollution on public health. Thus the medical officer of Burnley, Lancs, compares blood tests on women in Burnley showing 75 per cent of red blood corpuscles with corresponding tests in Denmark where 100 per cent was found, and the difference is ascribed to the variation of atmospheric pollution. Such observations tend to give the impression that smoke is a nuisance which is undesirable but possibly to be tolerated. The contents of this Spring Number contains evidence that the results can be much graver, leading to numbers of fatal results. In 1948, in Donora, a small industrial town of fourteen thousand inhabitants in Pennsylvania, there was an attack of smoke and fog such as to cause the death of twenty people within twenty-four hours. Investigation on a national scale put the cause down to a combination of circumstances (partly topographical as the town lies in a valley which is long and narrow); the weather was still, cold and anticyclonic; and local industry was concerned with heavy steel work with the consequent production of sulphurous products of combustion. These conditions recall similar experiences in 1930 at Liège in the Meuse Valley. The same results are conceivable in Great Britain under extreme conditions, and the only prevention would be the avoidance of atmospheric pollution.

Primates at the British Museum (Natural History)

A guide to the fossil remains of man in the Department of Geology of the British Museum (Natural History) was written by the late Sir Arthur Smith Woodward and appeared in 1915. Although it reached a third edition in 1932, it has been out of print for some years. In the meantime, new discoveries in Africa, Asia and Europe had so enlarged the picture of man's early evolution that a fresh approach was essential, and the preparation of a new guide was undertaken by Prof. W. E. Le Gros Clark. This was published a year ago; but the demand has been so heavy that a second edition has been prepared. In this, after sketching the background of the principles of classification and evolution, Prof. Le Gros Clark treats the history of the group of primates, both living and fossil, in such detail as will enable the student to appreciate the evolutionary aspects of the origin of man. The implements and culture of early man, however, which played such an important part in his subsequent development, are dealt with in a separate guide, "Man the Tool-Maker", by Dr. K. P. Oakley. Copies of the guides may be obtained from the Museum, price 2*s.* 6*d.* each.

Anniversaries of Famous Chemists

A number of the *Proceedings of the American Academy of Arts and Sciences* (78, No. 1; 1950) is devoted to short biographies of chemists and summaries of their work in twenty-seven cases in which the centenary or polycentenary of the date of birth or death falls in the year 1950. These biographies have been prepared by Prof. E. H. Huntress. Among them are outstanding personalities such as Brühl, Gay-Lussac, Dumas, Wöhler and Hess; such names as D. Bernoulli, Heaviside and K. F. Braun are also included, although they were not chemists. References to periodical literature containing portraits and photographs are given. Of the individuals treated, nineteen are 100-year anniversaries, five are 150-year memorials, while the remaining three represent celebrations of 250, 300 and 400 years, respectively. The notices are detailed enough to be useful and interesting, references being given for the outstanding contributions of the persons concerned.

Manchester Museum: Annual Report for 1948–49

The annual report of the Manchester Museum for the year ending July 31, 1949 (pp. 24; Manchester: the Museum, 1950), records that the period under review was a notable one in the history of the Museum. This was not so much on account of any remarkable progress made during the year, but because of various long-term policies that were initiated. During recent years shortage of staff and lack of money have been serious handicaps. The improvement of finance—chiefly due to the increase of annual grants from the City and the University—have made it possible for the committee to increase the staff in several directions. This increase of staff—professional, administrative and technical—is already reflected in increased activity in the exhibition galleries, overhaul of reserve collections, carrying out of various works of conservation, publishing literature relating to the collections, and in advancing scientific research. All these are major functions of a museum, and it is gratifying to record that the Manchester Museum is placing its increased income to these purposes.

Biological Indicators in the Northern North Sea

Marine animals, the distribution of which is imited to oceanic water-masses of defined characters, [illegible] be used for indicating the movements of such r-masses into other areas. As 'biological indic-[illegible]' they may provide powerful tools for the physical nographer. Salps and doliolids may be so used ndicating Atlantic oceanic water intruding on to Continental Shelf. In a publication of the Scottish e Department, Fisheries Division, entitled entific Investigations, 1949, No. 1: The Dis-ution of Thaliacea (Salps and Doliolids) in ttish Waters, 1920 to 1939" (pp. 44; Edinburgh l London: H.M. Stationery Office, 1949; 2s.), Dr. J. H. Fraser has examined plankton hauls en over a period of twenty years by Scottish arch vessels and has produced evidence of much ue to the physical oceanographer and fisheries uralist. The numbers and distribution of salps d doliolids in the northern North Sea have varied uch from year to year and accord with the hydrographical observations. Influxes of Atlantic water are variable and do not occur in Scottish waters when there are large influxes into the English Channel and vice versa.

Clayton and Manville Fellowships and Grants

Under two bequests, the Clayton Bequest and the Manville Bequest, the Institution of Mechanical Engineers has made the following awards for post-graduate training, experience or research in mechanical engineering, for research at the places mentioned: *Clayton Fellowships*, 1950: J. Halling (Imperial College of Science and Technology, London, on "Rolling Friction with Special Reference to Surface Finish"); E. P. Hotchen (College of Technology, Manchester, on "The Measurement of Flue Gas Temperatures"); John Houghton (Queen Mary College, London, on "The Effect of End Constraint on Thin-walled and Solid Cylinders of Hyperbolic Aerofoil Shape"); R. V. Macbeth (King's College, London, on "The Combustion of Oil Fuels"); G. Moss (King's College, London, on "A New Form of Continuous Filter"); F. Ellis (Imperial College of Science and Technology, London, on "Certain Aspects of Hot and Cold Rolling by Photo-elastic and Other Methods"). *Manville Fellowship and Clayton Grant*, 1950: B. Mills (University of Birmingham, on "The Flow of Gas Through Poppet-type Exhaust Valves at Subsonic and Supersonic Velocities"). *Clayton Grants*, 1950: E. Harvey (Imperial College of Science and Technology, London, on "A Method of Jet Propulsion for Marine Application"); H. C. Barty (for development of "Damping Devices for Road Vehicle Suspension").

Announcements

In connexion with the International Congress of Anatomists, meeting at Oxford, the University of Oxford has conferred the honorary degree of D.Sc. on Prof. George W. Corner, director of the Department of Embryology, Carnegie Institution of Washington, Prof. W. M. Woerdeman, professor of embryology in the University of Amsterdam, and Dr. L. S. B. Leakey, curator of the Coryndon Memorial Museum, Nairobi.

Mr. W. A. Robertson, forestry adviser to the Secretary of State, will be retiring from his present post at the end of this year, and Mr. F. S. Collier, at present chief conservator of forests, Nigeria, has been appointed to succeed him. Mr. Collier will take up his duties in the new year.

The annual conference of Aslib (incorporating the Association of Special Libraries and Information Bureaux and the British Society for International Bibliography) will be held in the University of Bristol during September 22–25. Further information can be obtained from the Secretary, Aslib, 4 Palace Gate, London, W.8.

A symposium on the techniques of subjective appraisal is to be held in London on October 14. The programme is to be divided into two main topics: (*a*) stimulus-sensation relationship; (*b*) the subject as an assessor of sensation. The organisation is in the hands of a committee consisting of Dr. D. W. Fry, Department of Phonetics, University College, London, Prof. R. C. Oldfield, University of Reading, and Dr. R. G. Hopkinson, Building Research Station, Garston, Watford, Herts (*secretary*); further information can be obtained from Dr. Hopkinson.

A two-day joint meeting has been arranged by the Edinburgh Section and the Fine Chemicals Group of the Society of Chemical Industry, to be held in Edinburgh during October 6–7. The programme includes an address by Dr. F. Bergel, chairman of the Fine Chemicals Group, on "The Biological and Therapeutic Significance of Organic Phosphates occurring in Nature"; and the third Lister Lecture of the Society, to be delivered by Prof. G. F. Marrian, professor of chemistry in relation to medicine in the University of Edinburgh, under the title of "The Adrenocortical Hormones". Further particulars can be obtained from the honorary local secretary of the Edinburgh Section, Mr. G. W. Walker, c/o T. and H. Smith, Ltd., Wheatfield Road, Edinburgh 11.

Wellcome Pharmaceutical Research Fellowships of £350 each for one year have been awarded to the following: Miss M. Dawson, for research at the School of Pharmacy, Royal Technical College, Glasgow, where she is on the staff, on the properties of pyrogenic substances; Mr. J. R. Hodges, for work at the School of Pharmacy, University of London, in pharmacology; and Mr. G. P. Lewis, for research at the Welsh National School of Medicine, into the properties of a group of newly synthesized antihistamine compounds.

OCCURRENCE OF A PHOSPHORIC ESTER IN CERTAIN BACTERIA: ITS RELATION TO GRAM STAINING AND PENICILLIN SENSITIVITY

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THE methods of Gram staining at present in use vary only in detail from that originally discovered by chance and described by Gram[1] sixty-six years ago. They rely upon three essential processes. The organisms are allowed to adsorb Crystal Violet (444-tris-dimethylamino-triphenylmethane) or one of its homologues from a concentrated aqueous solution at about pH 7 for about a minute. Adsorption equilibrium is nearly achieved, and whether Gram-positive or Gram-negative, the cells take up a weight of dye amounting to 10 per cent or more of their dry weight. The stained cells are 'mordanted' by treatment with an aqueous solution of iodine in potassium iodide, or of any one of a wide variety of substances (picrates, chromates, trinitrobenzoates) forming salts with Crystal Violet which, like the complex iodide $(C_{25}H_{30}N_3{\cdot}I + I_3)$[2], are almost insoluble in water but sparingly soluble in neutral organic solvents such as acetone or alcohol. The stained, mordanted preparation is washed briefly in alcohol or acetone. The organisms from which the stain is rapidly eluted by the organic solvent are called Gram-negative, whereas those from which a small proportion is eluted only very slowly are called Gram-positive.

The longer retention of a portion of the stain by the Gram-positive organisms has generally been considered to be due to the presence of a special component, and opinion has been more or less equally divided as to whether this component is a chemical substance which adsorbs the stain specifically, or whether it takes the form of a physical barrier to the outward diffusion of the stain. The main evidence in favour of retention by a physical barrier came from the observation that the capacity for retaining the Gram stain was destroyed if the cells were mechanically ruptured[3]. But the weight of this observation was largely lost when it was shown that if the autolysis and dispersion of the cell contents which follow mechanical rupture are prevented by previous heating or other fixation methods, the cells do not lose the dye-retaining property[4]. Presumably, the movement of the stain from some matrix in Gram-positive cells is retarded, either because of the high affinity of the stain for the components of the matrix, or because of its low rate of diffusion out of the matrix, or because of a combination of both factors.

It was shown by Deussen[5] that when yeast cells underwent partial autolysis or if they were extracted with mineral acids or alkalis they became Gram-negative. He expressed the opinion that the nucleic acid recovered from the cell extracts was responsible for the Gram staining because, if the extracted Gram-negative cells were treated with the nucleate recovered from the extracts, they could be made Gram-positive again.

Deussen's view was contested by Schumacher[6] on the grounds that much of the nucleic acid could be extracted from the yeast cells in 2N hydrochloric acid without destroying their Gram-positive character; but the cells could be made Gram-negative by subsequent extraction with lipid solvents in the presence of mineral acid. Schumacher believed that the component which retained the stain was a lipoprotein; for cells which had been made Gram-negative by acid and lipid solvent extraction were found to recover the dye-retaining property when treated with the ether-soluble Gram-positive phospholipids obtained from the cells by the extraction procedure. The possibility of the participation of lipids in Gram staining had already been suggested by some of the first research workers in this field[7], who observed that Gram-negative cells could be made Gram-positive by plating them with lecithin.

With the studies of the Stearns[8] on the effect o[illegible] pH upon the retention of the stain in the Gra[illegible] technique, a good case was built up for believin[illegible] the positively charged stain was ionically b[illegible] and attention was again focused upon the str[illegible] negatively charged cell constituents. Followi[illegible] report by Dubos[9] that the loss of the capacit[illegible] retaining the Gram stain in autolysing pneum[illegible] occurred more or less concomitantly with the ap[illegible] ance of ribonucleic acid and ribonucleoprotein i[illegible] autolysate, Stacey and others[10] suggested that [illegible] essential component responsible for Gram stai[illegible] was magnesium ribonucleate. They observed [illegible] after the dye-retaining property of certain G[illegible] positive organisms had been destroyed by auto[illegible] or by extraction with sodium cholate, it coul[illegible] restored by adsorbing magnesium ribonucleate u[illegible] the damaged cells—a now familiar but not altoge[illegible] conclusive experimental device; for although [illegible] staining of a 'reconstituted' organism may be larg[illegible] due to the material adsorbed upon the damaged cell, the Gram-positive character of the normal intact organism is not necessarily due to the same cause. We have recently found that particles of the order of 1 μ in diameter made of the weakly acidic gel obtained by treating gelatin with formalin stain intensely Gram-positive. Evidently acidic lipids, acidic protein and nucleic acids are all capable of retaining the Gram stain under appropriate conditions[11].

A somewhat different approach to the problem of the Gram stain was described by Gutstein[12], contemporary with the work of Schumacher. He investigated the nature of the site of stain absorption by determining the affinity of the site for a number of acidic, basic and lipid soluble dyes, and for acidic and basic mordants. The conclusion reached was that the Gram stain is taken up by a cortical layer which is special to Gram-positive cells. This layer consisted, he believed, of a basic ground substance, holding an acidic component that could be stained with Victoria Blue after extracting the nucleoprotein. The Gram staining was attributed to the acidic cortical component.

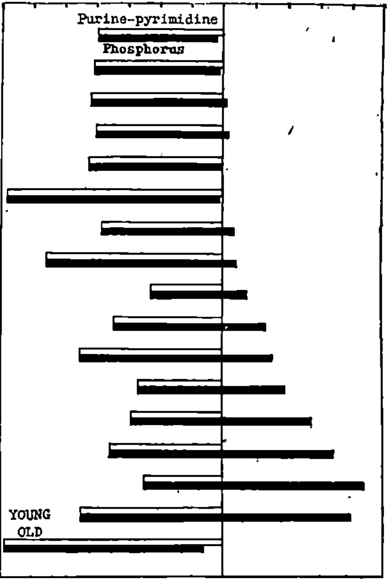
Attention had previously been directed to the difference in the nature of the external margins of

Gram-positive and Gram-negative organisms by observations on their digestibility by proteolytic enzymes and the sensitivity of the organisms to lysis in alkali. Kantorowicz[13] found that although all the organisms which he studied were resistant to pepsin and trypsin if undamaged, the Gram-negative group became susceptible to lysis after some change had occurred to the surface following heating to 70° C. In the following year, it was shown by Kruse[14] that the wall of Gram-negative cells is broken by dilute sodium hydroxide ($N/10$) and the cells lyse, whereas the Gram-positive wall is resistant. The observations of these two workers were afterwards confirmed and extended by Smith[15]. More recently, Bartholomew and Umbreit[16] found that crystalline ribonuclease will cause the loss of the Gram-positive staining character of a wide variety of heat-treated Gram-positive organisms, and they considered that a superficial part of the ribonucleic acid must be responsible for the staining reaction of Gram-positive cells. A similar conclusion was reached by Webb[19] from studies of the specific lytic action of lysozyme.

If the retention of the Gram stain is due to the presence of a particular substance, this substance would be expected to occur in much larger quantities in Gram-positive than in Gram-negative organisms. Jobling and Petersen[17] found that the lipids extracted from some Gram-positive bacteria differed from those of Gram-negative bacteria in that the former often gave larger iodine numbers and presumably contained a larger proportion of unsaturated fatty acids; but the differences were not large, and varied widely with the nature of the medium on which the organisms were grown. According to Schumacher[6], the lipoprotein responsible for the Gram staining of yeast gives on acid hydrolysis a Gram-positive "nitrogen free, phosphoric acid containing unsaturated fatty acid" which cannot be obtained from Gram-negative organisms. So far as we are aware, these observations have not been further elaborated. In a recent review by Stacey[18], it was stated that "the ratio of the relative amounts of the two types of nucleic acid differs in some Gram-positives from that in some Gram-negatives. Thus, in *Cl. Welchii* and streptococci, the ribo deoxyribotype is greater than 8/1, while in *Bact. typhosum*, *B. Shigæ*, *B. proteus*, etc., it is 1·3/1." But experimental values were not quoted in support of this view. We have made some measurements on the nucleic acid and associated fractions of a number of Gram-positive and Gram-negative organisms which do not show any marked systematic differences in the ratio of ribonucleic acid to desoxyribonucleic acid for the two groups of organisms, the value of this ratio generally being about 4/1, as shown in the accompanying table. Nevertheless, our observations appear to be relevant to the problem of the Gram stain, and may account for measurements of the ribonucleic acid content of Gram-positive organisms being erroneously high.

Comparison of the ultra-violet absorption at 260 mμ with the organic phosphorus content of the Schmidt and Thannhauser[20] 'ribonucleic acid' fraction of *Micrococcus pyogenes* var. *aureus* indicated that there was about 30 per cent more phosphorus than could be accounted for on the basis of a tetranucleotide structure[21]. A substantial part of the excess phosphorus has now been traced to a particular phosphoric ester (*XP*). This ester accounts for more than 20 per cent of the total phosphorus of *Mic. pyogenes*.

A survey of a small group of Gram-positive and Gram-negative organisms has been made in order to discover whether this phosphoric ester is a component special to Gram-positive cells. All the organisms studied were grown in the same medium and harvested at the approach to the stationary phase except where otherwise indicated. The ultra-violet estimations of ribonucleic acid as micromoles of purine-pyrimidine per gram dry weight (mean molar extinction coefficient 8,200) and organic phosphorus as micromoles per gram dry weight in the 'ribonucleic acid' fraction are shown in the table. The distribution of the phosphoric ester *XP* is more or less in accord with the Gram classification, those organisms which contain *XP* being Gram-positive and those which do not being Gram-negative. Two values are shown for the Gram-variable[22] *Neisseria*; one, obtained from a young growth, stained fairly Gram-positive and contained much *XP*, but the other, from an older growth, stained completely Gram-negative and contained no *XP*. It is interesting to note also that the Gram-positive *Neisseria* culture contained considerably less ribonucleic acid than the Gram-negative one. The growth of *Clostridium sporogenes* had passed into the stationary phase before harvesting and stained Gram-negative; but *Clostridium welchii*, which like *sporogenes* contained no *XP*, was definitely Gram-positive when harvested and appears to be an exception to the parallelism of *XP* content and Gram staining.

Organism	Gm. stain	Ribonucleic acid as μ moles purine–pyrimidine per gm. 600 500 400 300 200 100	*XP* μ molés per gm. 100 200 300 400	$\frac{R}{D}$	*P.S.*
Escherichia coli (MS)	–				–
Escherichia coli (H)	–			3·4	–
Proteus vulgaris 882	–			4·4	–
Aerobacter aerogenes A.	–				–
Clostridium sporogenes	–			7·1	+
Cl. welchii NCTC 6784	+			5·4	+
Mycobact. phlei (Sohn)	+			5·0	–
S. fæcalis (Dunn)	+			3·6	±
Yeast (bakers')	+			11·0	
L. casei helveticus	+			4·0	±
S. fæcalis (ST.)	+			3·7	±
Micrococcus *M. pyogenes*	+			8·1	+
aureus (D.)	+			6·0	+
B. subtilis (from Hay)				3·4	++
C. xerosis NCTC 7247	+			3·4	++
Neisseria catarrhalis	+			3·3	++
NCTC 3622	–			5·9	++

R/D stands for the ratio of ribo- to desoxyribonucleic acid, and *P.S.* for penicillin sensitivity; growth inhibition range shown by – = > 10, ± = 10 to 1, + = 1 to 0·1, ++ = 0·1 to 0·01 I.U./ml.

It was observed by Churchman[23] in some classical studies on the sensitivity of more than a hundred bacterial species to the growth-inhibitory action of Gentian Violet (Crystal Violet and lower homologues) that there was a 90 per cent correlation between sensitivity of growth to the dye and staining with it by the Gram technique. The *Neisseria* and *Cl. welchii* and *Cl. sporogenes* were among the main exceptions. There is consequently a complete correlation between sensitivity to Gentian Violet and the presence of the phosphoric ester *XP* in the small group of organisms which we have studied.

The good correlation between the penicillin sensitivity and *XP* content shown by the data of the table led to a study of the natural variation of the *XP* content of a culture of *Mic. pyogenes* var. *aureus* during growth and the effect of penicillin on the course of the variation. In the normal culture, the *XP* content expressed as micromoles of phosphate per gram dry weight was about 300 at the beginning of growth, fell to about 150 during the logarithmic phase and rose again to a resting value of about 300 in the stationary phase. The addition of 1 μgm./ml. (50 μgm./mgm. cell dry weight) of penicillin G to the culture in the late log phase caused the total amount of the phosphoric ester *XP* in the culture to decrease almost linearly to about one-half in the space of one mean generation-time, although during this period slow growth of the culture continued. When growth ceased, the *XP* content of the cells had fallen to less than 50 micromoles of phosphate per gram.

The only biochemical change which has been reported to be initiated immediately after the initial attachment of penicillin to growing cells is the increase in the free nucleotide content[24]. It is evident that the *XP* content begins to decrease also promptly after the initial attachment of penicillin. The synthesis of *XP* is prevented; but its utilization and breakdown is not prevented by the action of the penicillin.

Experiments with disintegrated cells have shown that the phosphoric ester *XP* is attached to the cell envelopes. The presence of this ester in the cell envelopes suggests that the inhibition of its production by penicillin may be connected with the disturbance of cell wall expansion in penicillin-treated cells[25] and with the impairment of function of the osmotic barrier[26] and of the transfer systems located therein[27].

We have been able to confirm the observations of Gutstein[12] and Schumacher[6] that certain micro-organisms do not become Gram-negative after most of the nucleic acid (more than 90 per cent of the ribonucleic acid) is extracted. But it was found that the Gram staining of the cells afterwards diminished as the *XP* was removed by prolonged extraction. In the same way, the intensity of the Gram staining of cells growing in the presence of penicillin has been found to follow their *XP* content. We are consequently inclined to accept Gutstein's view of the arrangement of the components of the cortical layer of Gram-positive bacteria and to consider that the phosphoric ester *XP* represents part of the acidic cortical component which he described[12].

In our experience there is no correlation between ribonucleic acid content and Gram staining; but such a correlation might erroneously be observed if *XP* phosphorus were mistaken for ribonucleic acid phosphorus. We consequently find it difficult to accept the view[10] that the essential component of the so-called Gram complex is magnesium ribonucleate. It seems, however, that there is a strong correlation between the Gram-staining reaction and the presence of the acidic component *XP*. This makes possible the chemical recognition of Gram-positive organisms on a quantitative scale. The correlation of the *XP* content and the capacity of organisms for retaining Gram's stain involves also a correlation with the other characteristics of Gram-positive organisms, their susceptibility to lytic agents, their autolysis and enzymic degradation, their capacity for accumulating amino-acids, the physiological effects of Crystal Violet, penicillin and other substances selectively active upon this group.

It is hoped that the work now in progress in our laboratory on the origin and nature of the *XP* fragment and the relationship of it to physiological function will throw light on its physico-chemical relationship to the known characteristics of Gram-positive organisms.

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LONG ASHTON RESEARCH STATION

A 'FIELD day' was held at the Long Ashton Research Station on July 11, on the occasion of the annual meeting of members of the National Fruit and Cider Institute. Visitors were conducted around the plantations, where they saw field trials, including particularly those dealing with the manuring of blackcurrants and strawberries, mineral deficiencies of apples and potatoes, and systems of culture and management of apples and pears; machinery for pest and disease control, designed at Long Ashton, was demonstrated. In the Cider House an exhibit of fruit, photographs and charts provided information about the varieties of cider apples recommended for planting, while another section dealt with the manufacture of apple juice.

In the laboratories were various exhibits which perhaps appealed more to the research worker, as they showed the work now in progress in the investigation of fundamental problems.

Sand culture. The plant nutrition sand culture section included the demonstration of equipment needed to study micro nutrient deficiencies in crops on a large scale. The automatic apparatus used to purify several tons of sand for this work was exhibited. This is designed to circulate several hundred pounds of sand at one time in contact with mineral acid or other extracting reagents. Steam issuing under pressure from a special jet assembly is used to transport and heat the sand and acid. The steam is generated in a 30 kW. automatic electrode boiler. The equipment is housed in a building with forced ventilation and neutralizing pits for waste acid. Sand treated in the apparatus is practically devoid of available micro nutrients and contains as little as 10^{-5} p.p.m. molybdenum. Several 'Pyrex' glass continuous distillation units and synthetic ion-exchange resins provide an adequate pure water supply.

Experimental work in progress in the sand culture section includes studies on molybdenum nutrition of *Brassicæ* in relation to nitrogen supply; nutrient balance experiments with potato; relation of heavy-metal toxicity to iron nutrition of sugar beet; elucidation of factors in soil acidity and the accumulation of micro nutrients by crop plants. The work on potatoes demonstrated the complexity of nutrient interrelationships; for example, iron, potassium and phosphorus levels are critical factors in the appearance of deficiencies of each of these elements and of calcium; low potassium accentuates iron deficiency and low phosphorus diminishes chlorosis; iron supply modifies the translocation of potassium and the availability of phosphorus.

Rapid chemical tissue tests. In another laboratory rapid chemical tests for the diagnosis of the mineral status of crop plants were demonstrated. In diffusion methods the easily soluble nutrients are extracted from predetermined portions of fresh plant material, using an acetate buffer solution. Tests for potassium, magnesium, calcium, phosphorus, nitrate nitrogen, and manganese at normal and deficiency levels are made on suitable aliquots of the extracts. Toxicity levels of chlorine, manganese and aluminium can also be determined. In maceration methods Waring and N.I.R.D. blenders are used for the extraction of nutrients from fresh plant tissues. A special carbon, 'Darco *G* 60', is used to clarify the tissue extract. The nutrient levels roughly parallel those obtained by the diffusion method, but are at a higher level.

'Pyrex' glass macerators are used to extract the micronutrients, namely, iron, copper, zinc, lead, nickel, cobalt, etc., from fresh plant material, and special chemical methods are used for their detection. The method is in use to study aspects of the effects of heavy metals on iron metabolism in economic crops. The chemical tissue test data are related to manurial treatment, final yields of crops, and ash analysis of the plants. The methods are valuable aids for a quick diagnosis of a mineral disorder in crop plants.

Radioactive phosphorus. Radioactive phosphorus (P^{32}) is being used to 'tag' phosphatic fertilizers in nutrition experiments on fruit trees and in other investigations on the effect of grass cover-crops in orchards. It is also being used to follow the course of systemic insecticides in plants. Up to the present time, much of the work at Long Ashton has been designed to determine the amount of phosphorus-32 which can be used without invalidating experimental results by radiation injury to the plants. The technique employed, including the use of the Geiger counter and other apparatus, was demonstrated.

Aspergillus niger as a test organism for mineral nutrients. Another exhibit showed the method of using *Aspergillus niger* (Mulder's *M* strain) as a test organism to determine magnesium, copper, zinc and molybdenum available in soils to crop plants. If any essential mineral element is omitted from a basal culture solution containing all others at satisfactory levels, the growth of the fungus, as judged by dry weight and sporulation, is markedly reduced. The response to the addition of this element in various amounts is specific and quantitative; thus a growth series can be prepared for any essential element, which is assessed by intensity and colour of spore cover and dry weight of mycelium. Test materials of soils, tissue extracts or ash of plants are placed in basal solutions containing all the mineral elements other than the one to be determined, and the growth of the fungus under these conditions depends on the amount of nutrient it obtains from the material added. The application of this method to soil problems has shown magnesium deficiency in the presence of potassium shortage, copper deficiency in certain alkaline fen soils where cereal crops were affected and in sandy soils where fruit trees showed 'dieback' symptoms, zinc deficiency in a sandy soil where apples and pears suffer from 'little leaf', and molybdenum deficiency in acid soils where *Brassica* crops showed 'whiptail' symptoms.

Plant hormones. Three different methods in use at Long Ashton for the biological estimation of plant-growth substances were demonstrated. (1) A modified form of the *Avena* coleoptile cylinder test in which the growth of coleoptile sections floating on the surface of the test solution is measured. (2) The *Coleus* leaf abscission test. Excised portions of *Coleus* nodes, each with an attached petiolar base, are mounted on damp filter paper. The cut end of the petiole is then covered with a small disk of filter paper impregnated with the test solution, and the time taken for the abscission layer to develop is noted. (3) The tomato ovary test. In this test unpollinated tomato ovaries are treated with known volumes of test solution and the rate of growth of the young fruitlets is measured over a period of six days. The growth is compared with that induced by known amounts of 2-naphthoxyacetic acid.

By means of charts and diagrams, it was shown how these tests are being used to study various pomological problems, in particular the cause and control of fruit-drop in apples and pears, and the winter dormancy of buds of fruit trees.

Systemic insecticides. This exhibit showed the residual toxicity of apple seedlings to *Aphis pomi* produced by application to the soil of *bis*(β-fluoroethoxy)methane, $CH_2(OCH_2CH_2F)_2$, *bis*(dimethylamino)fluorophosphine oxide, $[(CH_3)_2N]_2POF$ and *bis*(dimethylamino)phosphonous anhydride, $[(CH_3)_2N]_2P.O.O.PO[N(CH_3)_2]_2$, at amounts ranging from 500 to 25 p.p.m. of soil. The phytotoxicity of the materials on apple seedlings and their effect on growth was also demonstrated.

Photographs were used to show the residual toxicity of the above materials to *A. pomi* when applied in aqueous solution to the leaves of apple seedlings.

Virus diseases of tree fruits. Little is known of the actual extent of virus diseases of fruit trees in Britain, but virus-like symptoms are commonly seen in orchards; a number of specimens showing leaf symptoms probably caused by virus infection were shown, including mosaics, ring-spots, line-patterns, and necrotic spots. In addition to leaf symptoms, virus infection can cause changes in growth habit; this type of symptom was illustrated by rubbery wood of apple and stunt of plum. In rubbery apple, lignification of the wood is irregular and delayed, with the result that the young branches are flexible and soft and the tree has a 'weeping' habit of growth; in stunted plum the wood in the shoots is very poorly developed, while the tissues outside the wood are thick and spongy, and as a result the shoots are very brittle. In both diseases the internodes are shortened. Neither of these diseases causes leaf symptoms on the host on which they were first recorded, but plum stunt causes a faint mosaic on the cherry root-stock *F*.12/1, an example of which was shown. G. T. SPINKS

ELECTRONIC INSTRUMENTS AND DEVICES

AT first sight, the exhibition of the Institution of Electronics (N.W. Branch), held at Manchester during July 19–21, was perhaps a little disappointing after last year's brilliant display; but a closer inspection revealed that, although there were fewer spectacular demonstrations, a remarkable number of new, ingenious and useful devices were on show. Since it is obviously impossible to mention them all in the space allowed, a few of the most novel and interesting exhibits will be described.

An outstanding feature of the exhibition was the substitution of television demonstrations for the usual film shows. The receivers used were all built by members of the Institution, either from a commercial kit of parts or from government surplus equipment, and a short lantern lecture on the elementary principles of television preceded each demonstration.

Among the high-vacuum equipment displayed by British American Research, Ltd., was a new type of gauge known as the 'Alphatron', which has a linear response from 1 micron to 10 mm. of mercury. It is an ionization gauge in which a small quantity of radium provides a constant source of alpha-particles as the ionizing agent, and is consequently more robust and stable than the conventional type which uses electrons emitted from a heated filament.

Dawe Instruments, Ltd., displayed a stroboscope specially designed for viewing the moving shuttle of a textile loom. It uses an extremely high-intensity flash which gives a clear view of a moving object at very low repetition-rates, and a remote phase-control enables the operator to view the shuttle at any position during its traverse. The same firm also demonstrated its sound-level meter, which has been completely redesigned and now, while retaining the features of the earlier model, has its size and weight reduced by approximately one-half.

A high-voltage insulation tester which gives aural warning of the approach of a breakdown was displayed by the English Electric Co., Ltd. A continuously variable D.C. potential of up to 10 kV. is derived by rectification of the output of an air-cored transformer which is fed by a high-frequency valve oscillator. The A.C. components of the ionization current which precedes breakdown are amplified and fed to a small loudspeaker. The instrument is portable and, since the maximum current obtainable is 0·5 mA., it is completely safe. Among other equipment demonstrated by this firm were a 5-kW. induction heater designed as a general production tool rather than for specialized work, and a stepless controller for ¼–½ h.p. D.C. motors using a magnetic amplifier and metal rectifiers.

Interesting demonstrations of the phenomenon of electron diffraction were provided by Ferranti, Ltd. Cathode ray tubes are used in which a specimen of crystalline material is supported in the beam and the diffraction pattern observed on the screen. This firm also has available a continuously pumped tube in which specimens can be changed at will.

The equipment displayed and demonstrated by Fielden (Electronics), Ltd., was an excellent example of the way in which one or two basic instruments can be made to serve a large number of specialized purposes. In particular, the proximity meter, displayed in its basic form at last year's exhibition, and which depends on the measurement of very small capacity changes, has been made the basis of a bewildering variety of new instruments. Perhaps the most interesting application is in a new type of recorder which has the sensitivity of a high-grade pointer galvanometer but sufficient power to operate a substantial pen. A servo mechanism combined with the proximity device causes the pen to follow the pointer by maintaining a constant capacity between light vanes fixed to each. There is thus no mechanical contact between the meter and the recording mechanism. A similar principle is involved in an instrument for recording changes in level of a liquid as in a manometer or thermometer. Other applications which were illustrated involved counters, tolerance gauges, moisture indicators and a recording hygrometer.

A new standard signal generator by Marconi Instruments, Ltd., provides a continuously variable output from 0·4 micro-volts to 4 volts in the frequency range 15 kc./s.–30 Mc./s. Several unusual features are incorporated: a crystal-controlled oscillator for calibration checking and a novel form of concentric terminating unit are of special interest. The latter provides three output conditions—source impedances of 75 ohms and 30 ohms and a dummy aerial—and the fundamental circuit of each is indicated by a line diagram which changes as the switch is changed.

Metropolitan-Vickers Electrical Co., Ltd., displayed the precision wave-guide test gear for the 3-cm. band which has been developed in conjunction with the Telecommunications Research Establishment of the Ministry of Supply. Its own centimetre-wave signal source, which is of extremely small dimensions, was also on show. The latter provides a signal, tunable between 8,500 and 9,700 Mc./s., from a 723 *A*/*B* reflex klystron with a built-in wavemeter and attenuator.

The new audio-frequency wave analyser displayed by Muirhead and Co., Ltd., has been produced in collaboration with the Pametrada Research Station, Wallsend. It is designed primarily to assist the investigation of noise and vibration in marine turbines, and operates in the frequency range 19–21,000 cycles. The weight and size of the equipment have been minimized by the use of resistance–capacitance circuits in place of the usual inductance–capacitance type which, at these frequencies, would require very large iron-cored chokes. The analyser has two selective amplifiers in series which may be exactly in tune, 3 per cent apart or 10 per cent apart, to provide three different band-widths.

A number of new valves which, hitherto, have not been manufactured in Great Britain were displayed by Mullard Electronic Products, Ltd. Of special interest were a 3-cm. band reflex klystron with an output of 25 mW., and two new thyratrons, one containing xenon and the other hydrogen. These should prove useful to workers who have been relying on supplies of American surplus equipment.

F. C. Robinson and Partners, Ltd., demonstrated the 'beta' thickness gauge made by the Baldwin Instrument Co., Ltd. A radioactive isotope emits β-rays which fall on an ionization chamber. Any material placed between the two will absorb part of the radiation, and the change in ionization can be related to the thickness of the sheet. The instrument is normally calibrated to read mass per unit area; but if a material of constant density is used it can be made to read thickness directly. Also on view at this stand was the Scophony–Baird home tape recorder, which gives remarkably high-quality recordings lasting half an hour on a 1,200-ft. reel of plastic tape impregnated with iron dust.

In conclusion, perhaps a word of congratulation to the exhibitors in general might be allowed on the extremely attractive, though modest, appearance of all the displays. C. A. TAYLOR

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1948–49

THE work of the British Electrical and Allied Industries Research Association for the year ended September 30, 1949, is reviewed in the twenty-ninth annual report, issued recently*.

The Association has long played a part in the scientific and technical development of the electricity supply industry, and this has been recognized by the British Electricity Authority by the adherence as ordinary members of the Association of the Central Authority and of the Area Boards. In reviewing the general structure of the Association, which is based on twenty-three sectional committees, stress is laid on the useful scientific liaison which the Association effects. These committees, which have a primary responsibility for advising on research policy in their respective fields, form a meeting ground for research workers from industry, government establishments and from the universities, and their influence is, in consequence, a good deal wider than might be inferred from their immediate responsibilities to the Association. It is pointed out that, as the Association serves an industry which has within the organisations of its members very great technical resources, it is natural that the Association itself should tend to pursue "longer term, more fundamental and background research".

The subject of electrical engineering materials stands very high in the list of the Association's activities. Important fundamental work on dielectrics has been carried on both in the Association's laboratories and on an 'extra-mural' basis in several university departments and at the National Physical Laboratory. Research on magnetic materials, directed towards the improvement of the quality of electrical sheet-steels and to the production of improved permanent-magnet materials, has, for the most part, been supported in university laboratories. Electrical discharge phenomena have been the subject of extensive research both in relation to problems of direct practical interest in connexion with circuit-breaking and also in the fundamental field. The application of the theory of the electrical discharge, which was developed by Mr. C. E. R. Bruce to certain astrophysical problems, has been further extended by him.

Among the numerous researches on very varied topics listed in the report may be mentioned: the use of wind-power for generation, further work on communication interference and radio interference, short-circuit stresses in transformers and parasitic forces in integrating electricity meters. A total of ninety reports was issued during the year. In a paragraph dealing with organisation and staff, an interesting comment is made on the incidental function which the Association performs in training young scientific staff for the electrical industry.

UNIVERSITIES AND MANAGEMENT

IN the concluding address to the British Institute of Management conference at Harrogate in November 1949, Lord Lindsay stated that we are living in an age of technological revolution and that the productivity of a modern nation depends upon science and perhaps even more so is connected with a spirit of scientific research. By scientific research is meant not just what is taught and produced in the natural science faculties but that taught and produced in any proper university environment. It is a restless inquiring spirit, and the economic success of a modern industrial nation depends upon how far that spirit is pushed right down through the whole of society. To achieve the things Great Britain requires will depend upon two factors, the first being the extent to which this spirit of scientific research goes; it should not be confined to people in the universities but sent right down to the men at the bench. The second is how far each individual has public concern, that is, concern with how the country is run, understanding of the common man and those items needed in the structure of society.

The responsibility of the university in relation to the job would therefore seem to be to produce the science and skill necessary for our modern economic situation—more especially to introduce the scientific spirit, thought and outlook—and to give everybody a sense of citizenship. This means that university training must not be purely specialized although it must have a specialist or technical side. "An arts degree tends to produce an awful lot of uplift and makes people somewhat impractical and out of touch with ordinary life." What is really required is specialization and general education. At the new university in North Staffordshire (Stoke) it is proposed to start a general course for students who will not know whether they are science or arts students in the first year. They will follow one course and thereby all have a common background of understanding. Since one of the regrettable academic trends in recent years has been the excessive departmentalization in technology and science it is hoped to form a community with a common aim and thought in North Staffordshire in which the professors will form an essential part.

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* British Electrical and Allied Industries Research Association. Twenty-ninth Annual Report, October 1, 1948, to September 30, 1949. Pp. 188. (Leatherhead: British Electrical and Allied Industries Research Association, 1950.)

Lord Lindsay then raised the question of what part the universities can play in education for management. He suggested that management needs certain technical information which can be learned in technical colleges, but that the university should only be concerned with providing future managers with a critical faculty and showing them the relevance of their subject studies to matters which are not specialized. The universities should not provide a special course in management and there should not be people in universities studying for a "B. Man" degree living together as potential managers. A student at the university who hopes to go into business management should study something that has a strong sociological side, like Oxford Modern Greats. At the university they should also be given a sociological bent of mind, the ability to see the importance of structure in organisation and groups.

T. H. HAWKINS

CONSTITUTION OF MARS

A PAPER by K. E. Bullen, "On the Constitution of Mars"[1], suggests that the earth and Mars are of the same primitive composition. On the basis of an earth model—referred to in the paper as model *A*—which was advocated by Bullen in "An Introduction to the Theory of Seismology" (1947), W. H. Ramsey assumed that the density variation in the earth's deep interior is essentially determined by pressure rather than by changes in the materials present, and found a discrepancy in fitting the planet Mars to the hypothesis that the terrestrial planets are of the same primitive composition. The discrepancy is considerably less than that found by H. Jeffreys on the hypothesis that the large change in density across the boundary of the earth's central core is due to a change of material rather than to pressure. Ramsey showed that the discrepancy could be removed if model *A* were modified to include an allowance for the gravitation of the heavier elements towards the centre of the earth.

In the present paper, Bullen shows that the discrepancy is fully removed by an earth model *B* instead of *A*, model *B* being constructed on the basis of a compressibility-pressure hypothesis. In this model there is a sharp density increase from 3·36 to 3·37 gm./c.c. at a depth of 80 km., followed by a fairly steady density gradient down to a depth of 2,700 km. After this the gradient increases sharply for the next 200 km., the density being 5·57 gm./c.c. at the base of the mantle. Inside the central core the density ranges from 9·74 to 12 gm./c.c. at a depth of 4,980 km., and then rises sharply, reaching a value of 17–18 gm./c.c. at the centre. This model is independent of the observations of the radius and mass of Mars and Venus, so that no *ad hoc* adjustments are involved in fitting it to the planets. In fitting Mars to the hypothesis of the same primitive composition for the terrestrial planets, the most satisfactory agreement is obtained on the assumption that Mars has an inner core in the same proportion by mass as the earth.

The calculations show that the results are consistent with a large proportion of nickel–iron in the inner cores of the planets, and some higher-density additional material. The subject is also discussed by Bullen and Ramsey[2].

[1] Bullen, K. E., *Mon. Not. Roy. Astro. Soc.*, 109, 6 (1949).

[2] Bullen, K. E., and Ramsey, W. H., *Mon. Not. Roy. Astro. Soc.*, *Geophys. Supp.*, 6, 1 (1950).

AIR HYGIENE AND AIRBORNE INFECTION

A SPECIAL report of the Medical Research Council, entitled "Studies in Air Hygiene"*, is a symposium written chiefly by a group of workers led by Dr. R. B. Bourdillon, who continued the work on problems of airborne infection and air disinfection begun under the direction of the late Sir Patrick Laidlaw and continued under Dr. C. H. Andrewes. It states in the preface that this publication must be accepted as a landmark in the study of air hygiene. Not only have various practical methods of air disinfection been discussed and compared, but also a reliable and easy technique for the quantitative estimation of bacterial contamination of the air has been found.

The work described in the report falls into four sections: first, there are detailed accounts of instruments developed for sampling air and experimental and theoretical examinations of factors which influence the efficiency of these instruments; second, the report discusses practical methods of air-disinfection, special attention being directed to the value of the aliphatic alpha-hydroxy-carboxylic acids; third, field studies of the levels of bacterial contamination of the air in theatres, homes, factories, etc., are described; and fourth, the report discusses a few animal experiments on the transmission of airborne infections. A critical evaluation of the different methods of air disinfection ends the report, of which the appendixes and five pages of references to the literature enhance its value.

Field trials now in progress will help to decide whether improved air hygiene will result in improved health. At present, the preface to the report warns us, we must not assume that unselective reduction of the number of bacteria in the air of buildings will necessarily reduce the number of overt infections of people living in them. On the other hand, Dr. L. Colebrook and his colleagues at the Birmingham Accident Hospital have shown that secondary infection of burns can be largely eliminated by strict aseptic technique carried out in a room ventilated by an abundant stream of filtered air; effective methods of laying blanket-dust have reduced cross-infection in fever and surgical wards; and appropriate methods of air hygiene have protected industrial workers from dangerous bacteria.

* Medical Research Council. Special Report Series No. 262: Studies in Air Hygiene. By R. B. Bourdillon, O. M. Lidwell and J. E. Lovelock; with W. C. Cawston, L. Colebrook, F. P. Ellis, M. van den Ende, R. E. Glover, A. M. Macfarlan, A. A. Miles, W. F. Raymond, E. Schuster and J. C. Thomas. Pp. iv+356+33 plates. (London: H.M. Stationery Office, 1948.) 7*s*. 6*d*. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Trifluoromethyl Derivatives of Phosphorus, Arsenic and Sulphur

THE synthesis of iodotrifluoromethane and iodopentafluoroethane[1] has opened up a route to the synthesis of organo-metallic compounds containing perfluoroalkyl groups. The mercurials CF_3HgI and CF_3CF_2HgI have been prepared by the reaction of the fluoroiodides with mercury in the absence of a solvent[2], and these may readily be converted into the corresponding dimercurials (for example, $Hg(CF_3)_2$)[3]. The reactions of iodotrifluoromethane with phosphorus, arsenic and sulphur have now been investigated and are found to yield organometallic compounds.

The interaction of yellow phosphorus and iodotrifluoromethane in sealed tubes at 220° is almost complete and leads to the formation of a mixture of $P(CF_3)_3$, $P(CF_3)_2I$ and $P(CF_3)I_2$. These compounds have been fully characterized and have boiling points 17·3°/760 mm., 73°/755 mm. and 133°/413 mm. respectively. Phosphorus *tris* trifluoromethyl burns in air, and, like the iodo compounds, is quantitatively hydrolysed to fluoroform by dilute alkali; this constitutes a convenient method of analysis.

The combination of arsenic with iodotrifluoromethane takes place smoothly at 220°, and similarly yields $As(CF_3)_3$ (b.p. 33·3°); $As(CF_3)_2I$ (b.p. 14°/54 mm.) and probably $As(CF_3)I_2$. These compounds are also readily hydrolysed to CF_3H.

The reaction with sulphur occurs at temperatures above 200°. One of the main products is thiocarbonyl fluoride, CSF_2, and in this respect there is a parallel with the reaction between iodotrifluoromethane and oxygen, which leads to the formation of carbonyl fluoride. The amount of thiocarbonyl fluoride present in the product increases with increase in reaction temperature. With a temperature of 205°, other products can be isolated, one of which has the molecular formula $C_2S_2F_6$ (b.p. 34·5°). It probably has the structural formula $CF_3—S—S—CF_3$, and is hydrolysed by alkali without the formation of fluoroform. The compound $CF_3—S—CF_3$ is also believed to be present in the reaction product.

The chemistry of these new organometallic compounds is being investigated in detail, and the study is being extended to include the corresponding pentafluoroethyl derivatives. The reactions of iodotrifluoromethane and iodopentafluoroethane with other non-metals and metals will be described in subsequent communications.

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G. R. A. BRANDT
H. J. EMELÉUS
R. N. HASZELDINE

University Chemical Laboratory,
Cambridge.
June 1.

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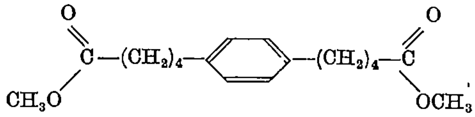
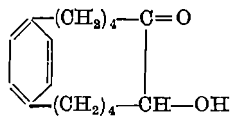
[1] Banks, Emeléus, Haszeldine and Kerrigan, *J. Chem. Soc.*, 2188 (1948).
[2] Emeléus and Haszeldine, *J. Chem. Soc.*, 2948 (1949).
[3] Emeléus and Haszeldine, *J. Chem. Soc.*, 2953 (1949).

Synthesis of a Benzene Ring with a Ten-Membered Para-Bridge

WE have recently investigated the synthesis of para-bridged benzene rings by dehydrogenation of maleic anhydride adducts of large ring dienes[1]. As this method is very laborious, we decided to find the lowest possible number of carbon atoms necessary to form a para-bridge starting from a preformed benzene ring, and then to use our dehydrogenation method systematically only for smaller bridges, which cannot be synthesized by ring closure. We have used the acyloin ring closure as described by Prelog and collaborators[2], and cyclized the diester



prepared according to Ruzicka and collaborators[3] from pure *p*-xylene. Surprisingly, we obtained the acyloin



in 70 per cent yield (b.p. 150–160°, 0·3 mm. mercury). After standing in the icebox, it solidified to a very low-melting crystalline solid (found: C, 78·07; H, 8·93; calculated for $C_{16}H_{22}O_2$; C, 78·01; H, 9·00 per cent). In alcohol with platinum oxide, this compound took up one mole of hydrogen and the corresponding diol was obtained (m.p. 102–103°; found: C, 77·39; H, 9·73 per cent; calculated for $C_{16}H_{24}O_2$: C, 77·37; H, 9·74 per cent). The diol consumed the theoretical amount of periodic acid. The high yield of the pure acyloin is interesting, as under identical conditions the cyclization reaction gives a yield of only 58 per cent *cyclo*tetradecoin. It seems that the shortest para-bridge will have less than ten and more than six carbons, which is the length of the shortest bridge in the meta-position[4].

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April 3.

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[1] *Canad. J. Res.* (in the press).
[2] Prelog, Frenkiel, Kobelt and Barman, *Helv. Chim. Acta*, 30, 1741 (1947).
[3] Ruzicka, Buijs and Stoll, *Helv. Chim. Acta*, 15, 1220 (1932).
[4] Prelog, Wiesner, Ingold and Hafliger, *Helv. Chim. Acta*, 31, 1325 (1948).

Quantitative Paper Chromatography on Mixed Solutions of Nickel and Cobalt, and Determination of both Elements

THE chromatographic procedure used in this work is as follows: Whatman paper No. 1 cut into 25 cm. × 1 cm. strips. Solutions to be determined (50 per cent by vol. hydrochloric acid) are taken from automatic horizontal burettes[1]. The solutions contain the desired amount (γ) of each cation in 0·01 ml. This volume of solution is deposited on the paper strip at 3·5 cm. distance from its top, and the drop is rapidly dried at 35–40° C.

This is to ensure the smallest possible salt spots. The strips carrying the salt spots and others containing hydrochloric acid (50 per cent) (0·01 ml.) are developed in parallel in a presaturated closed vessel. Presaturation is reached by leaving cotton wool soaked in the solvent chosen in the vessel overnight. The platform from which the paper strips will hang (downward development) is also provided with soaked cotton wool. The experiments are carried out in a room the temperature of which is controlled by thermostat (20° C.), on wooden tables.

The solvent chosen for developing cobalt separately from nickel has an acetone basis. It has been shown that 1·4 per cent alcohol and 1 per cent dry hydrochloric acid in acetone gives the best separation. We have succeeded with solvents containing less hydrochloric acid (up to 0·6 per cent by titration); but not more than 1·4 per cent alcohol[2]. First the alcohol is saturated with dry hydrochloric acid in ice and prepared freshly each week. This solution is kept on ice in a tightly corked bottle. The ternary solvent is prepared from this one, by adding acetone. It is freshly prepared each time the chromatographic vessel has to be newly saturated, which happens every two or three days.

This ternary solvent was used in the following experiments; but it seems that if ethyl alcohol is replaced by amylic alcohol and benzene is added, aqueous concentrated hydrochloric acid can be used instead of the gaseous acid. Such solvents have only been used qualitatively; they move very slowly in the paper, so that development takes much longer (4–5 hr.).

The acetone-base solvent is much quicker, and the front reaches 20 cm. from the deposit mark after 60–90 min. With this solvent, nickel remains where it was deposited, whereas cobalt travels along with the front.

When the development is considered to be sufficient, the strips are rapidly dried at 35–40° C. and cut up in the following manner for elution: nickel is on the upper half strip, measuring 10·2 cm. from the top; cobalt is on the bottom half. This strip is cut 1 cm. below the line of the front and 10·2 cm. measured off. Each strip is cut arrow-shaped at the bottom according to Martin's method.

Elution takes 2 hr. with hydrochloric acid (50 per cent by vol.). Eluted nickel is run directly in a 10-ml. calibrated flask, whereas cobalt is run in a small conical flask. Before taking the eluted strips away, both sides are rinsed with a few drops of 50 per cent hydrochloric acid. In both cases, the determinations have to be carried out in the absence of free hydrochloric acid. Therefore, the flasks receiving eluates are weighed, before and after elution, so as to know, as exactly as possible, how much acid has been used, and thus how much ammonium hydroxide is necessary to neutralize it.

Solutions to be determined are brought to 10 ml. with redistilled water after adding the following reagents[3]:

For nickel:	after neutralization of the	3-ml. hydrochloric acid (1 : 1)
	Spekker acid	0·1 ml.
	Ammonium citrate	1·00 ml.
	Iodine solution (0·1 *N.*)	0·25 ml.
	Dimethylglyoxine (0·001 *N.*)	2·00 ml. replaced in the blank by 2·00 ml. of (1 : 1) ammonium hydroxide
For cobalt:	after neutralization of the	3-ml. hydrochloric acid (1 : 1)
	Spekker acid	0·20 ml.
	Sodium acetate, 50%	1·00 ml.
	Nitroso-*R*-salt	0·50 ml. (absent in blank)
	Nitric acid (d=1·42)	0·50 ml.

Both elements are determined using the Spekker absorptiometer, water setting 1, cells = 1 cm., filter No. 602, and reference curves for nickel from 0 to 25 γ; for cobalt from 0 to 20 γ.

DETERMINATIONS OF BOTH ELEMENTS IN 0·01 ML. OF THE MIXED SOLUTIONS

Amounts in the mixture		Recovered		Means	
Cobalt (γ)	Nickel (γ)	Cobalt (γ)	Nickel (γ)	Cobalt (γ)	Nickel (γ)
10	10	10·08/10·24 10·16/10·00 10·18/10·10 10·08/10·24 10·08/10·40 10·37/10·16 10·32/10·16 10·16/10·02/ 9·96/	10·37/10·25 10·25/10·25 10·06/10·50 9·75/ 9·50 10·47/10·46 10·06/10·00 10·06/10·25 10·75/ 9·37	10·17 (+0·23–0·21)	10·14 (+0·36–0·77)
2	10	1·80/ 1·90 2·05	9·99/ 9·75 9·87	1·91	9·87
5	10	4·60/ 4·80 5·15	9·87/ 9·63	4·85	9·75
20	5	19·60/18·80/ 20·00	6·00/ 5·18/ 5·18	19·70	5·45

The procedure can thus be considered quantitative with the synthetic mixtures studied. Further investigations are necessary, using alloys. The limits of the respective proportions of both cations must also be studied. We propose to examine this procedure on a bigger scale, using paper pulp columns.

We thank the Institut pour l'Encouragement de la Recherche Scientifique à l'Industrie et à l'Agriculture (Belgium), and also the Fonds National de Recherches Scientifiques (Belgium) for financial help in carrying out this investigation.

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April 6.

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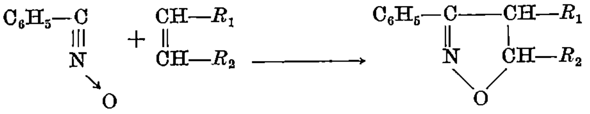
[1] *Mikrochemie*, 33, 2/3, 217 (1947).

[2] *Mikrochemie*, 34, (2), 219 (1949).

[3] Haywood, "Metallurgical Analysis".

A New Reaction of Ethylenic Double Bonds

In prosecuting our researches on the chemistry of nitrile oxides $R—C{\equiv}N{\rightarrow}O$, a class of compounds closely related to aliphatic diazo-compounds $R—CH:N_2$ and diazo-imides $R—N_3$[1], we have found that benzonitrile oxide (I) in ethereal solution reacts easily, at ordinary temperature or on slight heating, with the double bonds of ethylenic derivatives, to give Δ²-isoxazolines (II):



I II

exactly in the same way that aliphatic diazo-compounds and diazo-imides combine with ethylenic derivatives yielding respectively pyrazolines and dihydro-triazoles.

The following olefinic compounds have been tested by us with positive results: allyl alcohol, chloride, bromide, iodide, allyl ether and allyl sulphide; vinyl acetate, chloride and cyanide; methyl acrylate, methacrylate, maleate, fumarate, citraconate and mesaconate; maleic and citraconic anhydrides; styrene, ω-bromo-styrene, stilbene, benzylidene-acetone, indene, bicyclopentadiene. The yields are generally good. Allyl ether and allyl sulphide react with two molecules of benzonitrile oxide. With methyl maleate and fumarate, methyl citraconate and mesaconate, two different phenylisoxazoline-dicarboxylic acid dimethyl esters have been obtained, probably the *cis* and *trans* isomers which are theoretically possible for isoxazoline derivatives of type (II).

Since an ethereal solution of benzonitrile oxide is readily prepared from benzhydroximic chloride, $C_6H_5C(:NOH)Cl$ (in ether), and aqueous sodium hydroxide, and as the isoxazoline derivatives obtained are solids easily crystallizable and with definite melting points, the reaction can be of value for the identification of unsaturated liquid substances, and gives a new way for studying the reactivity of different types of double bonds.

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del Politecnico di Milano.

March 20.

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[1] Quilico, A., and Speroni, G., *Gazz. Chim. It.*, **76**, 148 (1946). Stagno d'Alcontres, A. Q., and Stagno d'Alcontres, G., *ibid.*, **80**, 140 (1950).

Structure of *cyclo*-Octatetraene

A COMMUNICATION[1] on the above topic has just come to our attention, in which the authors have reasoned from some frequency calculations to the conclusion that *cyclo*-octatetraene probably has the D_{4d} structure, with the D_4 structure a less likely possibility. It is the purpose of the present note to point out that the vibrational spectra[2] of the deuterium derivative of *cyclo*-octatetraene, published some time ago, enable the method of reasoning as well as the D_{4d} conclusion to be refuted.

The frequency calculations[1] are based on the D_{4d} model, which has high symmetry and thus lightens the numerical burden. On the basis of an assumed set of force constants, the twenty-six distinct frequencies were calculated and compared with the observed spectra. The agreement between calculated and observed values was then taken to indicate that the assumed structure was correct. Among others, there are the following difficulties with this argument. The calculation places a total of seven C—H bending frequencies in the region 1,550–1,750 cm.$^{-1}$, of which all but one are identified with observed frequencies in the range 1,442–1,734 cm.$^{-1}$. If this identification is correct, the frequencies would be calculated to shift in the deuterium analogue by about a factor 0·7–0·8. In practice, the shifts are very much smaller than this for *all* the principal observed frequencies in the range 1,442–1,734, the largest being about 10 per cent, and most changing by only 2–5 per cent. Thus the agreement between calculation and experiment would be badly spoiled in the deu[illegible] compound, which presumably has the same [illegible] and force constants.

The authors also state that [illegible] infra-red frequency at 675 has to [illegible] combination". This band is indeed very strong, being the most intense in the rock-salt region. It is therefore doubtful whether it should be assigned to a combination-tone. The difficulty is the more acute because at 629 there is a second, even stronger band, of which Saksena and Narain[1] were apparently unaware. Actually, we believe this pair of bands is a resonance doublet arising from interaction between an extremely intense fundamental and a combination tone. The analogous band in the deuterium compound is single[2].

The most serious objection to the D_{4d} structure is not mentioned by Saksena and Narain, although it has been pointed out several times[2,3,4]. The selection rules for this structure forbid the appearance of a given vibration in both infra-red and Raman spectra. There are observed about a dozen coincidences, all told, between the principal infra-red and Raman frequencies in *cyclo*-octatetraene, and one or two less in the deuterium analogue. These might, of course, be called 'accidental' or the result of violation of selection rules. It seems more straightforward to assume that the D_{4d} structure is not correct and to consider instead structures that require a limited number of coincidences, such as D_4 (10 coincidences) or D_{2d} (15). We believe the D_4 structure to be the actual one.

We have recently issued two reports[5,6] of our work on the structure of *cyclo*-octatetraene under the auspices of the U.S. Navy's Office of Naval Research. The subject-matter of these reports will be submitted in the immediate future for publication in the *Journal of the American Chemical Society*.

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June 9.

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[1] Saksena and Narain, *Nature*, **165**, 723 (1950).

[2] Lippincott, Lord and McDonald, *J. Chem. Phys.*, **16**, 548 (1948).

[3] Flett, Cave, Vago and Thompson, *Nature*, **159**, 739 (1947).

[4] Lord, *J. Chim. Phys.*, **45**, 47 (1948).

[5] Lippincott, Lord and McDonald, "Vibrational Spectra and Structure of Cyclooctatetraene", Tech. Rep. No. 1, Spectroscopy Laboratory, Massachusetts Institute of Technology.

[6] Lippincott and Lord, "The Thermodynamic Functions of Cyclooctatetraene", Tech. Rep. No. 2, Spectroscopy Laboratory, Massachusetts Institute of Technology.

'Heterochromatin'

THE purpose of this letter is to suggest that the use of the w[illegible]d 'heterochr[illegible]atin' in cytological and genetical l[illegible]e. The word was introduce[illegible]te those *Chromosomenstü*[illegible]mes that do not underg[illegible] and therefore remai[illegible]rphase and prophas[illegible]ect, particularly th[illegible] of the hetero[illegible]lture at low [illegible] and im[illegible]ame only

[illegible]he name [illegible] grou

of closely allied substances (for example, adrenalin, mucin, chitin). Our objection is twofold. First, it may be argued that the time has gone past when it was desirable to give to organic compounds names standing outside the accepted system of chemical nomenclature. Secondly, there is no evidence that what is called heterochromatin consists of a single substance or group of closely related substances having distinctive chemical characters. All that can be said with confidence about it from the chemical point of view is that deoxypentose nucleic acid and protein are present; but then these substances are constituents of chromosomes in general. A precise characterization in chemical terms is not yet possible.

The idea behind the word is actually morphological or spatial: it refers to a *region* of a chromosome or to a whole chromosome, not to a particular substance. The use of a word with a chemical connotation to describe a chromosome or a part of it is like giving a chemical name to a mitochondrion: if one were to speak of 'mitochondrin', one would be camouflaging the existence of a heterogeneous system.

The use of the adjective 'heterochromatic' is perfectly justifiable, since it suggests neither chemical homogeneity nor identity of chemical composition in all cells. The word is preferable to 'inert'—a misnomer already pointed out by Schultz[9] in 1936.

The word 'chromatin' is subject to nearly the same criticism as heterochromatin; but it was introduced long ago, at a time when the invention of such words may have been helpful. It is commonly used nowadays in the sense of a substance containing, consisting of, or showing the staining and other reactions of deoxypentose nucleic acid. In the present state of biochemical and genetical knowledge, it seems doubtful whether it continues to serve a useful purpose.

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Induction of Mutation by High-Energy X-Radi[illegible] a 2[illegible]

WITHIN a wi[illegible] kV.–2·2 MeV.) X-rays [illegible]ient in inducing mutat[illegible]mutations is direct[illegible] in roentgens[1]. [illegible] the high-e[illegible] has, for e[illegible] equal t[illegible] therefo[illegible] tions i[illegible]tron operating at 23 MeV. This produces radiations at all quantum energies from 0 to 23 MeV.

It is a common practice to judge the mutagenic efficiency of radiation by the frequency with which recessive sex-linked lethals are induced in the fly *Drosophila melanogaster*, and this method was used in the present investigation. The general procedure was to place irradiated young Canton-*S* wild males with females of apricot-bar, Muller-5 stock. Red-bar daughters from these matings were, in turn, mated to Muller-5 males. If no red-eyed, non-bar sons resulted from such a mating, a sex-linked lethal was suspected. All recorded lethals were confirmed by rearing one further generation of at least fifty flies from red-bar females crossed with Muller-5 males.

Flies to be irradiated were placed in gelatin capsules which were inserted into cavities in a pressed wood phantom. The beam from the betatron traversed at least 3 cm. of phantom before reaching the flies. The betraton was operated to produce a maximum quantum energy of 23 MeV. and the intensity was about 100 r. per min. Dosage intensity was measured with a Victoreen 100-r. condenser chamber placed in the cavity during a preliminary run of the betatron. Dosages recorded have been called 'roentgens'. A single dose of 2,000 r., 5,000 r. or 7,000 r. was administered to each lot of flies.

All the irradiated *X*-chromosomes which were tested for mutations were obtained from sperms which functioned in fertilization within twenty days of the treatment.

As may be observed from the accompanying table summarizing the results, the average percentage mutation per 1,000 r. high-energy X-rays is 1·70. The corresponding figure for ordinary X-rays as given by Lea[1] is 2·89 per cent. This would indicate that the high-energy radiations are only 0·59 as efficient as ordinary X-rays for the production of lethal mutations. This is in essential agreement with Luce, Quastler and Skaggs[2], who obtained a value of $m = 1 \cdot 4 \pm 0 \cdot 3$ when 20-MeV. X-rays were used on sperms.

X-radiation dosage (r.)	Number of *X*-chromosomes tested	Number of lethals observed	Calc. No. of lethals per 1,000 r.	Per cent mutation per 1,000 r. $(m \pm \sigma)$
7,000	120	17	2·43	$2 \cdot 03 \pm 0 \cdot 49$
5,000	272	22	4·40	$1 \cdot 62 \pm 0 \cdot 34$
2,000	451	15	7·50	$1 \cdot 66 \pm 0 \cdot 43$
Totals	843		14·33	$m = 1 \cdot 70 \pm 0 \cdot 45$
Control	396	0		

The standard deviations given in the last column of the table were determined from $\sigma = \dfrac{m}{\sqrt{\text{number of lethals observed}}}$

The reason for the difference in effectiveness doubtless lies in a difference in the distribution of ionizations in the irradiated material. High-energy electrons have longer tracks and produce sparser ionization on the average than do low-energy electrons. The densely ionized tail-portion of an electron track will constitute a smaller proportion of the total ionization in the case of high-energy electrons. Since for the production of some lethals two or more ionizations in close proximity may be required, we might [illegible] these lethals to be produced with a lower [illegible]cy when high-energy X-radiation is used than [illegible] X-radiation.

[illegible]ge with pleasure the assistance of [illegible]Haslam and L. Katz in making the betatron available for this work. Thanks are also due to the National Research Council of Canada and to the National Cancer Society for financial assistance.

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Identification of Transplanted Tissues in Chick Embryos by Marking with Phosphorus-32

THE technique of transplantation in early chick blastoderms developed by Waddington[1,2] has hitherto been handicapped by uncertainties in distinguishing host from graft tissues during analysis of the resulting embryo. In Amphibia this difficulty has been resolved by heteroplastic grafting between differently pigmented species[3,4], or by the use of vital stains which could be fixed in the tissues[5]. Not a little of the superiority of amphibian embryos as experimental material is due to these techniques. Analogous methods have failed to give an adequate solution of the difficulty in chick embryology. Conveniently available species (as used by Waddington and Schmidt[6]) are not sufficiently distinct histologically, and vital staining is not apparently always well localized[7] and its fixation for subsequent examination in paraffin sections, though possible[8], is not reliable.

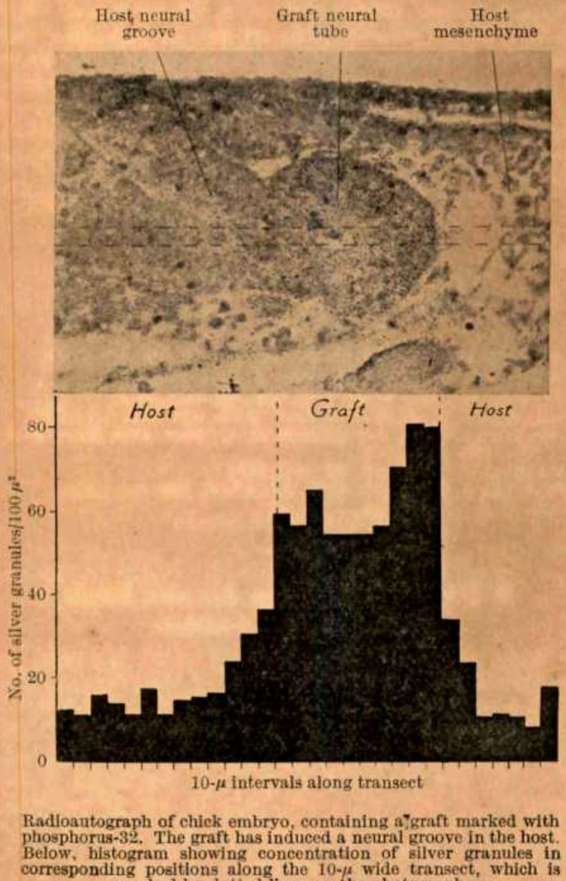
We have found that effective distinction between host and graft tissues of the chick can be obtained by marking one or the other with phosphorus-32, and afterwards preparing an autoradiograph of serial sections of the operated embryo. The technique is as follows.

The injection, 10–15 μC. of phosphorus-32 into the albumen of unincubated eggs, is made with sterile precautions into the side of the egg to avoid an initial high concentration immediately over the blastoderm. The injection site is sealed with paraffin wax and the eggs are left for eighteen hours at room temperature with occasional turning. They are then incubated in the usual way for 12–24 hr., according to the stage required for operation. Waddington's transplantation procedure and tissue culture technique are then followed, taking the host embryo from an injected egg and the donor from an untreated egg, or *vice versa*. After cultivation for the usual twenty-four hours, morphologically normal development has occurred in most specimens, though a few are believed to have failed through overdosage. The embryos are fixed in Bouin (2 hr.), dehydrated rapidly and serially sectioned in paraffin. After taking down to water, the slides are covered with autoradiograph stripping film (Kodak, Ltd.) and kept in the dark for fourteen days[9]. They are then developed, stained and mounted. So far, no entirely satisfactory staining technique has been devised; but useful results have been obtained with very dilute Hæmatoxylin followed by Aurantia (a method developed by Mr. J. E. Marner). The intensity of exposure of different regions of the emulsion can readily be estimated by counting the number of silver granules in unit area. Marked and unmarked regions are, however, usually distinct enough for such counting to be unnecessary.

In order to translate with confidence the distribution of silver granules in the emulsion into the distribution of host and graft tissues in the underlying section it is necessary to be satisfied on two points: (*a*) that the radioactive phosphorus which produces the autoradiograph has not diffused to a serious extent from cells originally marked to those originally unmarked; and (*b*) that the scatter of emission of radiation from a radioactive region of the section does not cause a misleading exposure in the emulsion overlying neighbouring non-radioactive regions.

As to (*a*), the only relevant diffusion is of that fraction of the phosphorus which remains in the tissue at the end of the histological process. If diffusion occurred in such a way as to mark cells originally unmarked, or to destroy the marking of cells originally marked, then it would be expected that different extents of positive exposure would occur according to whether the graft was marked or the host was marked in an otherwise similar operation. No such difference has been observed in comparable experiments. Furthermore, closely contiguous tissues, judged on morphological grounds to be host and graft, such as a secondarily induced neural plate in contact with a graft neural plate, are perfectly distinctly marked.

As to (*b*), autoradiographs of embryos grafted in the way described show regions of high and low intensity of exposure which are sharply marked off from each other by narrow zones of rapid transition.



Radioautograph of chick embryo, containing a graft marked with phosphorus-32. The graft has induced a neural groove in the host. Below, histogram showing concentration of silver granules in corresponding positions along the 10-μ wide transect, which is marked by dotted lines on the photograph

In numerous instances the beginning of a zone of transition from high to low intensity coincides accurately with a morphological boundary in the underlying section. If there were a scatter of radiation in such a way as to make the regions of high exposure larger than the regions of radioactive tissue beneath them, then the graft-host boundary must in all these cases lie the precise distance away from the morphological boundary necessary to produce the observed coincidence, which is scarcely credible. This argument is particularly strong in the case of secondarily induced host neural plates where the graft-host boundary can be placed with some confidence at the morphological boundary. It may be concluded that the autoradiograph indicates the borders of graft and host tissue to within about 5 μ. An example, with quantitative analysis, is shown herewith.

There are obviously certain disadvantages to the technique we are describing. There is the difficulty of staining sections, adequately and consistently, through the emulsion. It can perhaps most conveniently be overcome by taking two series, of alternate sections, using a double-bladed microtome, and staining and mounting one series in the usual way, while the other is used for the autoradiograph (a technique due to J. F. Sloane and J. E. Harris, of the University of Bristol). The dispersion of particles around the source makes impracticable very accurate identification, say, of single cells within an intimate mixture of host and graft cells. Finally, the method is rather complex, though not so much so that it cannot be used as a routine. With its aid it should be possible to put past and future experimental results with chick transplantations (and no doubt transplantations in other organisms) on a firmer basis. We should add, however, that so far, in repeating the classical 'organiser' grafts of Waddington[2], we have found nothing to contradict his interpretations, made on morphological grounds; though dispositions of graft and host tissues of lesser importance, which would otherwise have been quite unsuspected, have frequently come to light.

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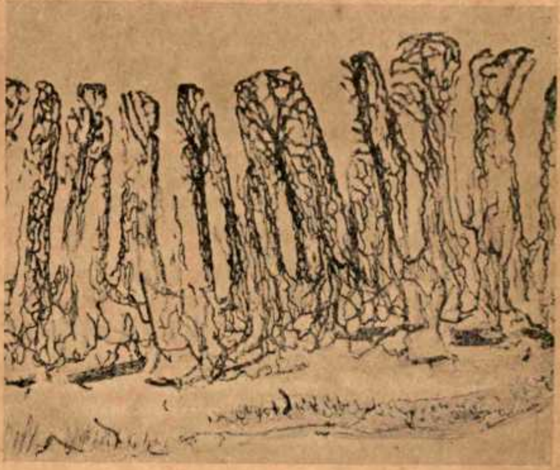
A Simple Technique for the Study of Vascular Pattern

MANY methods have been evolved for the purpose of demonstrating the microscopical vascular arrangements in tissues, difficulty having been encountered in selecting the ideal injection medium. The excellence of the results obtained by Trueta, Barclay, Daniel, Franklin and Prichard[1] in their investigations of the intra-renal circulation has brought into prominence the use of radio-opaque materials. It is evident from Barclay's account[2] of the methods that the injection procedure is without difficulty and results in good filling of vessels with a stable, homogeneous mass, but that the radiological and photographic aspects are more complex.



Longitudinal section of duodenum (42 μ). × 40

We have obtained satisfactory results with a considerably modified method which is less time-consuming, more economical and essentially simple. It is based on the conversion of the radio-opaque silver iodide to metallic silver by a photographic developer, and this obviates the radiological technicalities.

Materials. Our trials have been confined to guinea pig tissue, and the apparatus used for the injection process was based on the design used by Trueta and his colleagues[1]. Colloidal silver iodide (10 per cent) is employed as the injection mass, and it flows freely due to low viscosity. Barclay[2] noted that this preparation produced very satisfactory filling of fine vessels; but it had a tendency to become dislodged during the cutting of sections. We, however, have found that it is well retained in the vessels. The fluid is white and the process of injection can be observed in the tissues. In dealing with pale structures where blanching is not very evident, a little Brilliant Green can be added to the injection mass, as it does not adversely affect the colloidal state of the silver iodide. Fixation is effected with formol-acetate (an aqueous solution of 8 per cent formalin and 4 per cent sodium acetate), which also converts the colloidal injection medium into a firm gel. Any routine photographic developer may be used for the transformation of the silver iodide into silver.

Technique. Immediately after killing the animal, the thoracic and abdominal viscera are exposed by a ventral incision, followed by removal of the sternum and the anterior portions of the ribs. The thoracic aorta is freed for a small distance and cannulated. The injection is carried out at systolic blood pressure and naturally in a distal direction. The proximal portion of the thoracic aorta is severed in order to allow the displacement of blood in the cardiovascular system by the injection fluid. During the injection the viscera are kept warm and moist by the application of warm, wet towels. The injection is usually completed in from ten to fifteen minutes. The organs are removed, and portions of about 4 mm. thickness are immersed in the fixative solution for forty-eight hours. On completion of fixation, frozen sections are cut at a trial thickness of 40 μ. The most satisfactory range of thickness can later be assessed according to the degree of vascularity observed in the trial sections. The frozen sections are treated with the photographic developer until the injected vessels are seen to blacken—a period of about five minutes is satisfactory for *D*.163 (Kodak). After development, the sections are rinsed well in water, dehydrated, cleared and mounted in *D.P.X.* Liberal quantities of the mounting medium are required owing to the thickness of the sections. The vessels are revealed in jet black against a very indefinite outline of the general tissue structure.

For thin organs such as the stomach and intestine of small animals, the method can be applied to the study of the vascular network of the various layers. Portions of the fixed tissue are cleared by the method of Spalteholz[3], after previous development of the silver iodide, and mounted flat on a glass slide. The vascular architecture of the individual layers is observed by variation of depth of focus with the microscope.

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Cause of the Absorption of Water by Submerged Shoots

OBSERVATIONS made by Dixon and Barlee[1] recently have inspired a discussion as to the possibility of a transpiration into a saturated atmosphere[2,3]. Dixon and Barlee showed that shoots, placed in a supersaturated atmosphere or being submerged, continue to absorb water for several days. Experiments in pure nitrogen and with narcotics indicate the necessity of respiration. According to the authors it is very probable that respiratory processes supply the leaf-cells with energy to secrete water drawn from the vessels into the leaf spaces. Thoday doubts, however, that water taken up in such amounts could all be retained, and suggests the possibility of transpiration into a saturated atmosphere.

Apparently it has been overlooked by the authors mentioned that in 1935 I published a paper[4], by which in my opinion a satisfactory elucidation has been given of the causes of phenomena similar to those communicated by Dixon and Barlee.

Considerable absorption of water for several days by cut shoots, submerged or covered with 'Vaseline', was observed; this was especially pronounced in the dark. In the light the absorption proved to be insignificant or even negative. The course of the absorption paralleled exactly the course of the gas exchange. In accordance with Sen and Blackman[5], who observed an injection of submerged leaves with water, the cause of the movement of sap was attributed to the occurrence of small differences in pressure in the intercellular spaces, resulting from the different solubility of carbon dioxide and oxygen which are exchanged during the respiratory process. It was shown by means of small variations of temperature, alternate bubbling of readily diffusible hydrogen and air that slight differences of pressure from the order of 1–3 mm. of mercury completely suffice to explain the magnitude of the sap-stream observed. No intake of water was observed when the intercellular spaces were impregnated with water.

The exudated water is retained by the leaves. The weight of a leaf increased by 20 per cent, whereas the volume of the leaf remained the same. In accordance with this the amount of air in the intercellular spaces decreased considerably in the dark, whereas in the light it remained almost constant. Considerable amounts of water are absorbed in this way. A submerged shoot with six leaves weighing 6·355 gm., connected with a potometer, increased 1·032 gm. in weight in 86 hr.; 1·014 gm. entered through the cut surface in the same time.

Thus it appears that the continuous movement of sap is a result of respiration. The process proceeds as long as gas exchange is continuing and the intercellular spaces are not completely impregnated with water. Neither active secretion of water by the leaf cells nor transpiration in saturated air play a significant part in this process.

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Hypersensitivity and Tumour Development in Potato Tubers in Response to Infections with *Phytophthora infestans*

F_2 forms of a certain cross between a *W* variety and a common variety of potato, when inoculated with parabiontic strains of blight fungus[1], were found to produce tumours. These tumours develop on the cut surfaces of tubers which had been covered with a zoospore suspension of low concentration. They developed after an incubation period of 4–5 days at about 20° C. It is thought that this mode of reaction is linked with hypersensitivity to the parasite, because such a reaction has not been observed on a hypersensitive[2] (susceptible) genotype.

The hypertrophic growth of the affected tissues is caused by enlargement and multiplication of the cells which surround those cells that have been destroyed

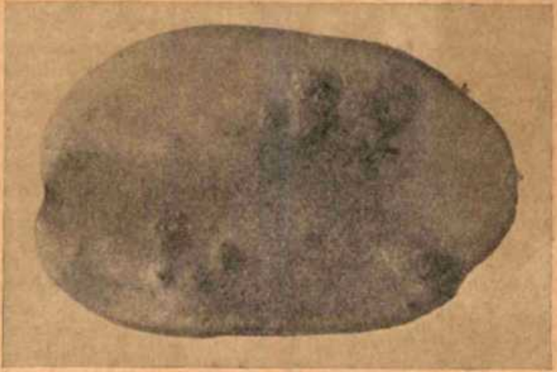

Photo.: *Hughes*

A tuber of an F_2 seedling showing tumours six days after inoculation with a parabiontic strain of *Phytophthora infestans* by the parasite. These enlarged cells which lose their starch content seem to be identical with normal gall cells. There is no indication of any formation of wound periderm-like tissues. Occasionally the fungus fructifies sparsely on the tumours, a condition never found in normal reacting tissues of hypersensitive genotypes; this is an indication that the tumours so found favour the development of the parasite.

The tubers of the same genotype differ in their capacity to react in the manner described. This variation is connected with physiological differences between the individual tubers of the same plant.

I suggest the following explanation of these phenomena. Besides the gene *R* which controls the degree of sensitivity of the affected tissues to the invading parasite, there is another gene (or genes ?) which enables the cells to grow and divide in response to the influence of substances released by the dying tissues. If, as appears, the 'tumourized' tissues are less sensitive than unchanged tissues, then the parasite has a greater chance of survival and fructification in the former than in the latter tissues.

The most striking feature of these experiments is that a parasite, known only as such because of its tissue-destroying properties, can stimulate certain host genotypes to develop tumours. Moreover, these observations indicate that this capacity of the host to react in such a manner is a stage beyond that of hypersensitivity in the phylogenetical development of the plant types concerned.

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Sharp Eyespot as a Severe Disease of Oats

SHARP eyespot of wheat[1], caused by *Corticium* (*Rhizoctonia*) *Solani*, is a common disease; but the lesions on leaf sheaths and straws are usually superficial, and there is no evidence that it is of economic importance. Hitherto, it does not appear to have been described on other cereals in Great Britain, though Oört[2] shows a photograph of it on rye in Holland, and Sprague records it on barley[3] and on oats[4] in America. This year a crop of oats has been found in Bedfordshire with many plants severely attacked by a *Rhizoctonia* resembling that obtained from sharp eyespot in wheat. The lesions in oats resemble those in wheat; but the fungus penetrates deeply into the tissues of leaf sheaths and straws, rotting the shoots. The disease is evidently serious; but the loss cannot be estimated because another parasite, the eelworm *Heterodora major*, is attacking the roots and reducing growth of the crop. Many barley and a few wheat plants are scattered among the oats and some show typical superficial sharp eyespot lesions; the vigorous growth of the wheat and barley does not seem to be affected, and contrasts vividly with that of the oats.

The suggestion that sharp eyespot is a more severe disease of oats than it is of wheat or barley is supported by sand culture experiments in which wheat, barley, oats and rye were inoculated with two isolates of *Corticium* (*Rhizoctonia*) *Solani* obtained from sharp eyespot in wheat. Lesions developed on the leaf sheaths of all four cereals, but oats and rye were much more severely affected than wheat and barley; the fungus penetrated more deeply into the shoots of oats and rye and killed about half the inoculated seedlings.

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Humidity and Temperature in Grass Microclimates with Reference to Insolation

IN view of a recent communication in *Nature*[1] by Miss Champness, it may be of interest to report certain investigations of grassland microclimates resulting from an inquiry into the behaviour of insect larvæ (mostly Tenthredinidæ) during 1947–49.

Shielded wet and dry thermocouples aspirated at a low rate in order to disturb as little as possible any thermal stratification were used in making air temperature and humidity observations in the face of direct insolation. Insect temperatures were taken per rectum, and leaf temperatures by threading thermocouples through leaves. The plots of grasses contained a mixture of species growing wild or semi-wild under conditions of varying density and height.

Curves of air temperature variation within the atmosphere enclosed by the grass have been obtained under suitable conditions of sunshine for vegetation from 25 to 60 cm. in height, thus bridging the gap as regards height between Geiger's[2] cornfields and Miss Champness's grass seedlings. The findings agree in general with their results. Clearly the quality and density of herbage affects temperature and humidity distribution (see also Roussakov[3]) and may compensate for height changes; for whereas in young corn the hottest layer of air is at ground-level and does not become remote from it until growth has proceeded for some time, in growing grass only a few centimetres in height the hottest air layer is already above ground-level. The extent of the cooler, wetter, lower microclimate depends upon the depth of penetration of the sun's rays, which is determined by the angle of these rays (varying diurnally and seasonally) as well as the physical conditions of the vegetation.

This was illustrated at Dundee by records of larval, leaf and air temperatures taken at different levels in vegetation 35–55 cm. in height at different times of the year. Temperatures of freely exposed larvæ and leaves during periods of insolation were 1–3° C. above air temperature. When shielded from radiant heat, leaves were at air temperature while larvæ were at temperatures slightly lower. In July, temperatures above that of air were recorded for larvæ and leaves in the upper half of grass cover, denoting considerable radiant heat penetration. Here a low hot-air zone was recorded. In September and October, plant temperatures fell almost to that of the air and animal temperatures lower, in situations only 5–6 cm. below the grass tips, denoting reduced radiant heat penetration. As expected, a high hot-air zone was noted. Similar results for radiant heat penetration were obtained by exposing differentially connected black-and-white thermocouples *in vacuo* at different levels.

In grass partially flattened due to previous exposure to very strong winds and thereby presenting

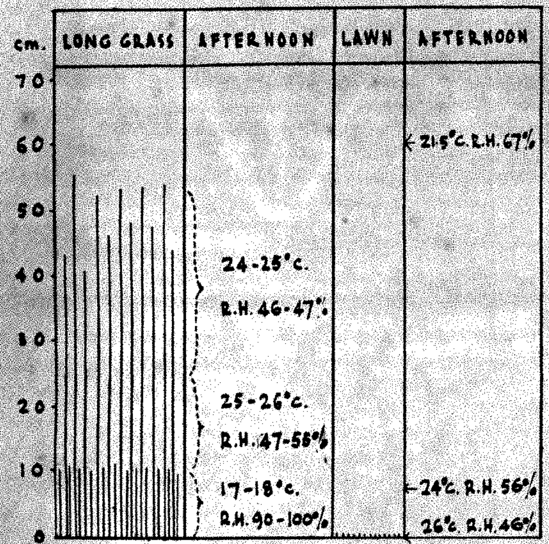

Diagram illustrating air temperature and humidity in relation to density (indicated by the closeness of the vertical lines) and height of grass during a July afternoon of strong sunshine and gentle breeze. The readings are representative of the general conditions existing in an environment varying slightly from point to point

an upper surface of increased density, the high hot-air zone was noted even in July. This observation is comparable to that of Geiger's, in which the appearance of influorescences caused variation in temperature distribution. The possibility must be noted, however, of seasonal variation in the physiological condition of leaves contributing to an alteration of radiant heat penetration[4] and leaf temperature[5].

As regards humidity, observations of the type important to the present argument have been carried out on only one occasion, in 45–55 cm. grass which had been allowed to grow from a lawn condition for three years. Here the added complication entered of an increased density of the lower zone due to the dead grass of previous years. In this case (see chart) the relative humidity roughly follows the temperature gradient, determined primarily by a considerable radiant heat penetration due to a July sun. The hottest layer of air shows a slightly higher relative humidity than the cooler upper air, presumably due to its proximity to the source of moisture in the matted layer. Observations taken during the same afternoon over an adjacent piece of ground which had been retained in its lawn condition showed a reverse relative humidity gradient due presumably to the drying out of the lawn surface.

It may therefore be suggested *à propos* Miss Champness's experiments that, apart from any considerations such as overcrowding, the density of vegetation necessary to retard evaporation sufficiently at low levels to produce a suitable nursery climate will vary not only according to type and height of vegetation, but also seasonally according as the effects of these factors are modified by variation in the angle of the sun's rays. Due to the relative shortness of any seedling herbage, there is the possibility that this factor may be varying significantly in a shorter period of time than the Dundee work in longer grass demonstrates.

A further feature of grass microclimates is the occurrence of temperature inversion during calm, clear nights. Such an inversion was observed at Dundee during the summer of 1947, when the air near the ground in the case of 35-cm. grass was found to be 2–3° C. warmer than above. This state of affairs persisted from dusk until the following morning. Unfortunately, humidity results are not available; however, since the temperatures concerned were around 10–15° C., any drying-out effect would be small.

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Principle of an Ion Source for Intense Beams

THE performance of ion sources, associated with accelerating tubes, is limited by space-charge phenomena, particularly troublesome in the vicinity of the extraction aperture. It is therefore desirable to avoid space-charge accumulation along the whole path of the ions. This can be obtained by changing the configuration of the extraction field. The extracting electrode is a short cylinder coaxial with the accelerating tube (a cylinder which replaces the conventional plate with a circular aperture), and the ions pass through a circular slit, machined in this cylinder. The initial velocity of ions is then perpendicular to the axis of the tube, and directed towards it. Let us assume the electric field in the tube to be uniform; then the trajectories are parabolas, all of which cross the axis of the tube at the same point if the beam is homogeneous in energy. For a suitable ratio of the extracting to the total accelerating voltage, this point coincides with the target, at the lower end of the tube. Rough calculations show that the usual orders of magnitude of total and extracting voltages, as well as the length and the diameter of tubes, are quite suitable for this method of extracting and focusing. The ion source must be, of course, either specially designed or suitably modified to fit this mode of extraction[1].

We intend to use a source modified from that of Alfvén's trochotron[2]. In this valve, the electrons follow trochoidal trajectories in crossed electric and magnetic fields. The effective length of the path can be considerably greater than the dimensions of the tube. (The negative 'rail' of the trochotron collects positive ions, when the pressure is not very low. An ion-gauge, based on this principle, has, for a filament emission of 3 m.amp., a sensitivity fifteen times that of the conventional ion gauge with an electronic emission of 20 m.amp.)

Unlike Alfvén, who uses a configuration of electric field favourable to electron concentration (Fig. 1,*a*), we have to apply an electric field focusing the positive ions on to the extracting slit. Such a field defocuses electrons and repels them on to the side walls (Fig. 1,*b*). This repulsion is compensated and the total focusing effect obtained by the use of an inhomogeneous magnetic field which, as is well known, concentrates electrons in its symmetry plane. In the conditions of electric and magnetic fields of Fig. 1,*b*, this focusing effect will exist only for electrons having energies above a certain minimum value. Electrons which have lost energy by collision escape the influence of the magnetic field and are trapped by the side walls. Slowed-down electrons, which no longer

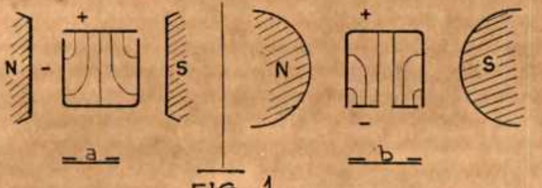

FIG. 1

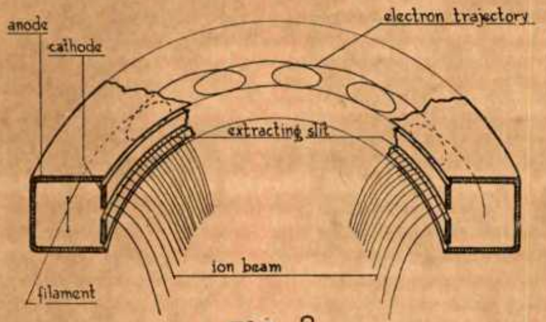

FIG. 2

have ionizing energy, are thus automatically eliminated, whereas, in many types of sources, they are trapped in the plasma, and can only disappear by recombination, diminishing the yield of the source.

Moreover, with a suitable configuration of pole pieces, one can produce magnetic fields which introduce a purely magnetic precession in addition to the precession due to crossed fields. This again increases the length of the path of electrons. In principle, precessions of opposite signs and of nearly the same absolute value should lead to the best result. In practice, one is limited by the instability of the electron beam due to space charge.

Two experimental types have been operated: a linear one for the study of basic properties, and a circular one as a tentative practical embodiment of the type of source described.

The theoretical assumptions were verified and the behaviour with respect to gas consumption and power dissipation found satisfactory. Examination of the adjustment is in progress.

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March 28.

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[1] Sommeria, J., in a paper to be published in *Le Journal de Physique et le Radium*, describes the use of a source of the Heil type which he has adapted to annular extraction.

[2] *Nature*, **160**, 614 (1947).

Extraction of the Electron Beam from a 30-MeV. Synchrotron

ELECTRONS of energy up to 20 MeV. have been extracted from the 30-MeV. synchrotron[1] at the Atomic Energy Research Establishment with the aid of a small shunt coil carrying a pulse of current.

The electrons are injected into the synchrotron from inside the equilibrium orbit, and are extracted when the magnetic field has reached its maximum value. The extraction occurs in two stages: the orbit is first expanded by means of pulsed coils above and below the 'donut'; this causes the electrons to spiral outwards until they reach the extractor shunt; the shunt then deflects them tangentially out of the machine.

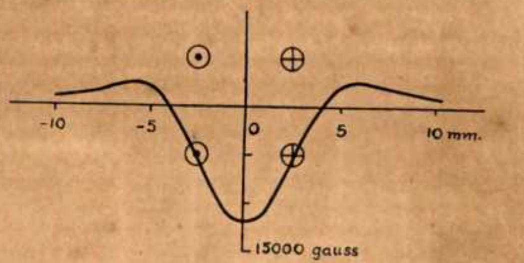

Fig. 1. Vertical field due to square conductor array of side 5 mm. carrying 6,000 amp.

The shunt consists of four conductors of length 6 cm. arranged 5 mm. apart in a square (Fig. 1). These conductors carry a pulsed current of up to 6,000 amp. peak, so timed that the current is a maximum when the electrons enter the shunt. The currents in the conductors produce a vertical field in the plane of the orbit, as shown in Fig. 1. This combines with the guide-field to produce the field shown in Fig. 2; there are two tracks of zero field T_1 and T_2, and it will be seen from the figure that any electrons falling outside T_1 will move over to T_2 and will oscillate about it, being thus carried out of the synchrotron. Unfortunately, the field at T_2 is such as to cause vertical defocusing, so that the shunt must be short; this means that the emerging electrons are still in the fringing field of the magnet, and that consequently the dispersion of the beam is increased.

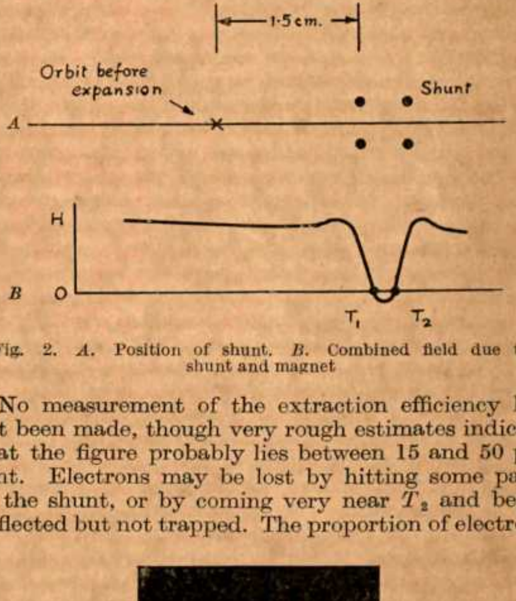

Fig. 2. *A*. Position of shunt. *B*. Combined field due to shunt and magnet

No measurement of the extraction efficiency has yet been made, though very rough estimates indicate that the figure probably lies between 15 and 50 per cent. Electrons may be lost by hitting some parts of the shunt, or by coming very near T_2 and being deflected but not trapped. The proportion of electrons

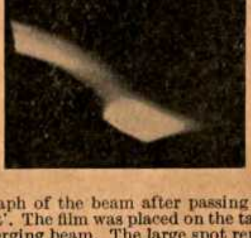

Fig. 3. Photograph of the beam after passing through the glass wall of the 'donut'. The film was placed on the tangential side-arm, at 35° to the emerging beam. The large spot represents the beam, and the curved tail is due to electrons leaving the shunt early or being imperfectly trapped. The curving of the beam is due to stray fields from the lead-in wires. Full size

deflected but not trapped should not be very large, however, since although the mean spiral pitch of the electron is of the order of 0·01 mm., there will be betatron oscillations with amplitude of the order of 1 mm. superposed on this, making the effective spiral pitch much wider. Nevertheless, 'photographs' of the beam (Fig. 3) indicate that about half the electrons are being lost in this way.

So far it has only been possible to extract electrons up to 20 MeV., though there should be no difficulty in extending this to 30 MeV. This limitation is not fundamental, and is due merely to insufficient current from the orbit expansion modulator.

We wish to acknowledge the debt to our colleagues for advice and assistance in this work.

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Harwell. April 17.

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Production of Beryllium-7 by Proton Bombardment of Carbon

We have detected beryllium-7 in graphite targets after bombardment by 160 MeV. protons accelerated in the 110-in. Harwell cyclotron.

Graphite disks of high purity were irradiated for about one minute, and were found to emit γ-rays with a half-life of about fifty days and energy about 0·5 MeV. (measured by absorption in lead), in addition to the 20-min. positron activity from the well-known[1] reaction $C^{12}(p,pn)C^{11}$. Radiochemical analysis, performed by Dr. F. D. S. Butement, showed that an isotope of beryllium was responsible for the long-period activity. The half-life and γ-ray energy agree with the known values for beryllium-7.

The carbon-11 activity was used as a standard for measurements of the yield of beryllium-7. The irradiated sample was completely enclosed in an aluminium sheath thick enough to stop all the positrons from carbon-11, and its activity measured with a Geiger counter. Since carbon-11 gives no γ-rays, the counter was detecting only the 0·51-MeV. positron annihilation radiation and the 0·48-MeV. γ-rays from beryllium-7; the difference between these energies was sufficiently small to make a counter calibration unnecessary, and the relative yields of carbon-11 and beryllium-7 could be obtained from a decay curve.

In preliminary measurements the cross-section for production of beryllium-7 from carbon-12 by 160-MeV. protons was found to be 11 millibarns $\pm$ 20 per cent. The cross-section for $C^{12}(p,pn)C^{11}$ at 160 MeV. was taken to be 61 millibarns (from results at Berkeley[2]) and the branching ratio[3,4] for the decay of beryllium-7 was assumed to be 0·115.

The possibility that the beryllium-7 might have been formed from carbon-13 or some impurity in the graphite can be ruled out. A cross-section of more than 1 barn would be necessary to produce the observed yield from carbon-13. The total cross-section of carbon for 150-MeV. neutrons is only 0·3 barn[5], and it seems reasonable to assume that no specific nuclear reaction in carbon-12 or -13 can have a cross-section approaching this value for 150-MeV. protons. A similar argument applies in the case of impurities; moreover, irradiations of a $(CH_2)_n$ (polythene) target, containing quite different impurities, gave the same value of the cross-section.

It is therefore assumed that the reaction $C^{12}(p,3p3n)Be^7$ has occurred, with a possibility that the protons and neutrons may be ejected in various combinations involving deuterons, tritons and α-particles.

We are continuing work on this reaction and intend to publish a more complete account. We wish to thank the cyclotron-operating team for their co-operation.

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May 22.

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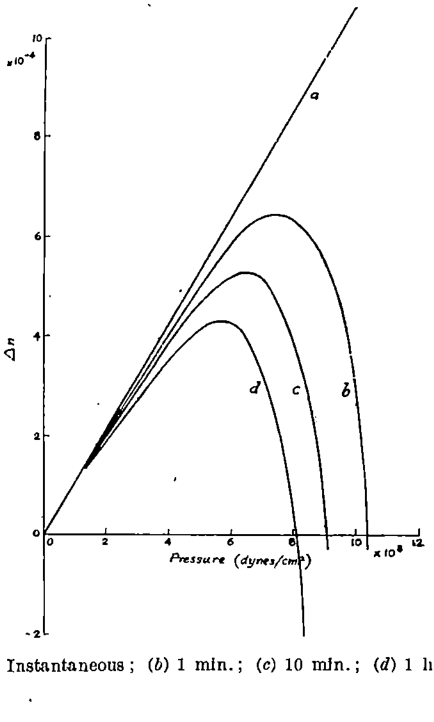
Stress-Birefringence in Polystyrene

The photo-elastic properties of polystyrene at temperatures above its softening point have been investigated earlier[1,2], and it has been found that under these conditions the stress-birefringence is in the opposite direction from that found for most other materials. This is in agreement with the results reported by Signer[3] on the flow-birefringence of polystyrene solutions. Signer pointed out that this behaviour would be expected if it is assumed that, when the molecular chains become aligned, the benzene rings orientate themselves at right angles to the direction of the chains; and, since the optical effect of the benzene rings is greater than that of the main chain, the net stress-birefringence will be *negative*.

No results appear to have been published on the photo-elastic properties of polystyrene at lower temperatures, and on examining the properties of this material in the form of 'Transpex II', it has been found that at room temperature the birefringence is



(*a*) Instantaneous; (*b*) 1 min.; (*c*) 10 min.; (*d*) 1 hr.

initially *positive* and proportional to the applied stress. The ratio between these two quantities, which is known as the 'stress-optical coefficient', may be seen from curve (*a*) in the accompanying graph to be about 10 brewsters. If stresses above about 10^8 dynes/cm.^{2} are maintained, the birefringence decreases with time, and if the stress is then removed a negative birefringence results. This residual birefringence then relaxes slowly. For pressures greater than 8×10^8 dynes/cm.^{2}, the birefringence is found to pass through zero and become negative even when the stress is maintained.

The graph shows the results obtained at 16° C. with monochromatic light ($\lambda = 5461$ A.) for polystyrene under compression when the stresses have been maintained for various times. These results appear to indicate that two distinct molecular mechanisms take part in the mechanical deformation of polystyrene at room temperature. On first applying a stress, sections of the molecular chains tend to become aligned, and this is associated with the elastic behaviour of the material. When the stress is maintained, however, an orientation of the benzene groups slowly occurs, and this 'flow' takes a corresponding time to relax when the stress is removed. It is hoped to publish fuller results elsewhere of the behaviour at different temperatures.

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April 4.

[1] Kolsky, H., and Shearman, A. C., *Proc. Phys. Soc.*, **55**, 383 (1943).

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Interlamellar Adsorption of Protein Monolayers on Pure Montmorillonoid Clays

ORIENTED flakes of the fine fractions (less than 0·5 μ) of montmorillonite and hectorite, when dipped in protein suspensions at *p*H values far below their iso-electric point, exhibit a behaviour similar in general to that observed by Gieseking and his collaborators[1]. The difference in technique, however, shows a striking modification in the resulting protein-clay complexes. After immersion in gelatin-suspensions of *p*H 2·5 and concentrations stronger than 1 per cent, unidimensional Fourier syntheses of the X-ray diagrams of the oriented flake suggest that: (*a*) two monolayers, 4·3 A. thick, of the polypeptide chains of the protein are taken up in the interlamellar space, and completely fill it; (*b*) each monolayer is strongly adsorbed on the clay mineral sheets, and a high degree of order along the *c*-axis is obtained in the sandwich thus formed. The X-ray diagram is analogous to that of the glycerol – montmorillonite complex. This lends strong support to the idea that surface adsorptive forces play a major part in the formation of these two-layer organic complexes in montmorillonoid clays.

It is also possible to obtain what appears to be a one-layer (4·8 A. thick) complex of gelatin with a *c*-spacing of 14·2 A. by two alternative methods: (i) by dipping the oriented clay flake in gelatin suspensions at concentrations 0·5 per cent and less; (ii) by dipping a flake of the two-layer complex in a 1 per cent gelatin suspension at *p*H values greater than 3·5. The X-ray diagrams of these flakes suggest that either (*a*) the monolayer taken up does not fill the interlamellar space completely, or (*b*) that the monolayer lies in the interlamellar space in a crinkled state, thus preventing any high degree of order in the *c*-dimension.

It is possible to pass from the one-layer complex into the highly ordered two-layer complex by dipping a flake of the former in a 1 per cent gelatin suspension at *p*H 2·5. Under exceptional conditions, which are difficult to reproduce always (that is, with flakes formed by very slow deposition of the clay particles of less than 0·1 μ diameter), a complex with a *c*-spacing of 26·3 A. is formed (in addition to the two-layer complex) which appears to be a four-layer complex. Like the one-layer complex, the four-layer complex does not show such a high degree of order in the *c*-dimension as is observed in the two-layer complex.

Identical results for the one- and two-layer complexes are obtained with edestin and pepsin suspensions. Flakes dipped in 1 per cent solutions of the amino-acids glycine and arginine at *p*H 2·5 give X-ray diagrams similar to that of the one-layer protein complex, except that the increment in the *c*-spacing is 3·5 A. In all cases the flakes are dried over phosphorus pentoxide in an evacuated desiccator overnight before X-ray examination.

The energy of adsorption between the clay sheets and the protein chains is primarily due to electrostatic forces reinforced by strong Van der Waals' attraction. This is sufficient to cause protein molecules in suspension to uncoil into polypeptide chains, which then easily penetrate the interlamellar space. The two-layer complexes are the most stable of the three kinds observed, each mono-layer being firmly attached to opposite clay surfaces. The thickness of the monolayer observed (4·3 A.) shows that side-chains must lie almost flat on the clay surfaces in the interlamellar space. This is not only in good agreement with the calculated and observed dimensions of polypeptide chains (from X-ray evidence) but also shows a remarkable similarity to 'State III' of the gel films of protein monolayers observed by Rideal and collaborators[2] on an aqueous base, although the orientation of side-chains with respect to the surface of the adsorbent is not the same.

The two-layer complex has some other significant characteristics. There is no uptake of glycerol or water after soaking the flakes in either liquid for more than forty-eight hours in the cold. This hydrophobicity is similar to that of amine-clay complexes described by Jordan[3]. However, the conversion of a compound, strongly hydrophilic in the natural state, into a hydrophobic complex by interlamellar adsorption is remarkable. Prolonged contact with *N* hydrochloric acid has no effect on the complex; with 0·2 *N* sodium hydroxide, the complex shows signs of being attacked slowly after forty-eight hours contact.

Acknowledgments are due to the Department of Scientific and Industrial Research for a grant; and to Dr. D. M. C. MacEwan for originally suggesting the problem on the lines of Gieseking's work.

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March 4.

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Gabor Diffraction Microscopy : the Hologram as a Generalized Zone-Plate

SINCE the publication of the papers of Gabor on diffraction microscopy[1,2], work has been going on in this Laboratory on the effect of varying the source-hologram distance and the hologram size on the position of the reconstituted image. It proves possible to represent the information obtained in a very simple way by the use of an instructive analogy.

It should be noted that a zone plate is a particular case of an artificially constructed hologram, corresponding to the introduction of a second coherent point source into the diverging beam from the first point source. A zone plate, moreover, when suitably arranged in front of a point source, duly reconstitutes the second point source, together with the symmetrically placed point on the far side of the original source. This follows from the fact that the zone plate has both a positive and a negative primary focal-length.

Pursuing this analogy, we may regard a hologram as a generalized zone plate, which transforms a point source into an image resembling the object used to generate the hologram. It is found that if the distance from the source to the hologram is regarded as the object distance (u), that from the hologram to the reconstituted image being taken as the image distance (v), they are related by the simple lens formula :

$$\frac{1}{v} \pm \frac{1}{u} = \frac{1}{f},$$

the positive or negative sign being taken according to the sign convention used. Hence, it is useful and proper to regard the hologram as having a focal-length f. In common with the zone plate, it acts as both a positive and a negative lens. This accounts for the double image formed, and also explains the observation that, if Gabor's condition that the object must be near the source compared with the hologram is disregarded, the two images are *not* formed symmetrically with respect to the source ; but their positions agree exactly with the results of operating on the wave-front from the source with a positive and a negative lens of equal numerical power.

It is found that the effective focal-length of the hologram varies with the wave-length, λ, and with a parameter L, representing the linear scale on which the hologram positive is reproduced from its negative, by the following relationship

$$f \propto \frac{L^2}{\lambda},$$

a result well known to hold for a zone plate[3].

It is a necessary corollary of the existence of the two focal-lengths that the hologram can act as a convex lens, and can thus produce its own reconstruction without the use of the auxiliary lens recommended by Gabor. Since the hologram is essentially a positive photographic reproduction of the Fresnel diffraction pattern of the object in diverging light, and the use of a point source and a hologram alone can only produce a Fresnel diffraction pattern of the hologram, it follows that a two-stage Fresnel diffraction operation can reconstruct an image of the original object. In this way the inverse relationships in the first diffraction operation are re-[illegible] to give a semblance of the original obje[illegible] reminiscent of the Abbé theory of mic[illegible] and the standard Fourier techni[illegible] crystallography.

There is one point at which the analogy with a zone plate appears to break down. The zone plate not only has a primary focus, but also a number of higher-order foci corresponding to powers which are odd integral multiples of the primary power. This, it seems, arises from the practice of constructing zone plates with abrupt changes from black to white at a sharp boundary, analogous to a square-topped wave. As is well known, a square-topped wave has a large number of Fourier coefficients, and thus the sharper the boundaries in a zone plate, the greater the number of orders obtained. The hologram, on the other hand, produced by a continuous tone photographic process, does not have sharp alternations, but ones more closely conforming to sinusoidal variations ; thus we expect the greater part of the diffracted energy to be concentrated in the first-order patterns. The use of an altogether unusual degree of photographic contrast might give rise to higher order effects; but none has been so far observed.

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April 15.

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[1] *Nature*, 161, 777 (1948).

[2] *Proc. Roy. Soc.*, A (July 7, 1949).

[3] See, for example, Jenkins and White, "Fundamentals of Physical Optics", 183 (McGraw-Hill).

Occurrence of 5-Methyl-Cytosine in Nucleic Acids

THE presence in a nucleic acid of the pyrimidine 5-methyl-cytosine was first reported in 1925 by Johnson and Coghill[1], who claimed its discovery among the hydrolysis products of tuberculinic acid. As their identification, however, was based solely on the optical properties of the crystalline picrate, the correctness of this report has been subject to speculation ; yet until the recent application of paper chromatography to nucleic acid analysis, there has been no published attempt to confirm their finding. Recently, using a chromatographic method, Vischer, Zamenhof and Chargaff[2] have estimated the purines and pyrimidines in deoxypentose nucleic acid from avian tubercle bacilli, and could find no trace of methyl-cytosine. Hotchkiss[3], however, has noted in hydrolysed thymus nucleic acid a small amount of a substance the chromatographic behaviour and ultra-violet absorption spectrum of which are compatible with its being 5-methyl-cytosine.

Taking advantage of the sensitive photographic technique of Markham and Smith[4] for the detection of ultra-violet-absorbing substances on paper chromatograms, I have now been able to demonstrate and estimate 5-methyl-cytosine in several animal and plant deoxyribonucleic acids, but not in certain viral and bacterial nucleic acids, including that of tubercle bacilli.

The bases liberated by hydrolysis of nucleic acids with formic acid (175° C. for 30 min.) are separated on one-dimensional paper chromatograms using as the solvent an aqueous solution containing 65 per cent *iso*-propanol and 2·0 N hydrochloric acid. In this system, guanine, adenine, cytosine and thymine are separated in that order, and it was noted first in chromatograms of nucleic acid from herring sperm that a faint additional spot is visible just beyond [illegible]tosine, which was also present when hydrochloric [illegible] was used for hydrolysis. A sample of this substance, isolated by eluting from large sheets of filter paper, was found to give no colour with ninhydrin and to withstand prolonged acid hydrolysis. It moved just ahead of cytosine in all chromatographic solvents tried, whether acid, neutral or ammoniacal.

This suggested that the new substance might be methyl-cytosine. Treatment with nitrous acid gave a product identical with thymine in its chromatographic behaviour and ultra-violet spectrum. Of the three substances which would yield thymine on deamination, the unknown was clearly different from 5-methyl-*iso*-cytosine (2-amino-4-hydroxy-5-methylpyrimidine, kindly provided by Prof. A. R. Todd), and was unlikely to be 2,4-diamino-5-methylpyrimidine in view of the effect an additional amino-group would have on chromatographic movement. It therefore appeared to be 2-hydroxy-4-amino-5-methyl-pyrimidine or 5-methyl-cytosine.

Recently, through the kindness of Mr. A. Pircio, of Fordham University, New York, I have obtained a sample of synthetic 5-methyl-cytosine, and have confirmed its identity with the natural substance by chromatography and by ultra-violet spectrometry. Absorption maxima occur at the following wavelengths: at *p*H 7, 274 μ; in 0·1 *N* hydrochloric acid, 212 and 283 μ; in 0·1 *N* sodium hydroxide, 287 μ.

Other available nucleic acids were examined for this new pyrimidine. By eluting from chromatograms run in *iso*-propanol-water – hydrochloric acid, concentrating the eluate, and chromatographing in butanol – water – ammonia, amounts of it as small as 1 per cent of the cytosine present (less than 0·1 per cent of the nucleic acid) could be detected and estimated. The following is a list of nucleic acids examined, all of which, except those noted, are of the deoxypentose type.

Source of nucleic acid	Methyl-cytosine content as molar % of cytosine
Calf thymus	6
Beef spleen	6
Ram sperm	5
Herring sperm	8
Locusta migratoria (whole)	1
Wheat germ	33
Tubercle bacilli, human and bovine	0
Escherichia coli	0
E. coli bacteriophages T_2 and T_6	0
Virus of gypsy moth polyhedral disease	0
Yeast (ribose type)	0
Turnip yellow mosaic virus (ribose type)	0

So far, 5-methyl-cytosine has been found only in deoxypentose nucleic acids from animals and higher plants, which contain relatively small amounts characteristic of the source. I am unable to confirm the claim of Rosedale[5] that in the nucleic acids of locusts and certain other insects thymine is quantitatively replaced by 5-methyl-cytosine.

The question arises whether 5-methyl-cytosine is a constituent of the deoxyribonucleic acid macromolecule or of a smaller molecule, perhaps another nucleic acid, mixed in the preparations. Herring sperm nucleic acid fractionated by ultra-centrifugation showed no difference in composition of sediment and supernatant. Nor is its composition altered by precipitation after depolymerization with 1 *N* sodium hydroxide. On the assumption that it consists of a single molecular species, the locust nucleic acid analysed would contain approximately one nucleotide of methyl-cytosine in every 400, corresponding to a molecular weight of about 150,000. In view of the evident complexity and specificity of nucleic acids, there seems to be no reason why this should not be so; yet a further attempt at fractionation would [illegible] worth while.

The thymus nucleic acid used was the gift of Dr. K. Bailey; ram sperm nucleic acid was prepared in collaboration with Dr. T. Mann; dried tubercle bacilli were provided by the Wellcome Research Laboratories, Ltd. I am grateful to Dr. K. M. Smith for providing facilities for this work, to Dr. Roy Markham for help and advice, and to Dr. J. D. Smith for preparation and analysis of nucleic acids from *E. coli*, bacteriophages and turnip yellow mosaic virus. The work was carried out while I was on transfer of research from the Division of Entomology, Department of Agriculture, Ottawa, Canada.

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April 3.

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"Polyploidy in Rabbits"

IN 1948, Prof. G. Häggqvist[1] reported the production of tetraploid frogs (*Rana temporaria*) by colchicine treatment at fertilization, all previous workers having been unsuccessful. Chromosome counts were not made. Instead, tetraploidy was inferred from the relatively greater volume of epidermal nuclei of some treated animals as compared with controls (ratio 1 : 1·87, the theoretical ratio for tetraploidy being 1 : 2·00).

These arguments are open to the objection that large significant differences in mean nucleus size can be found between diploid frog tadpoles, even of the same batch (Beatty, unpublished). In diploid newt larvæ, also, there is great variation between tadpoles, mean nuclear size in some being double that in others[2]. There is thus grave danger of identifying as polyploid a certain number of tadpoles which are, in fact, diploid. The nuclei of the epidermis are flat disks, of the same thickness in diploids and polyploids, and the volume of which is roughly proportional to their *area* as seen through the microscope. Häggqvist, however, calculated a mean diameter and then estimated nuclear volume as if for a *sphere*, stating that this source of error should be of the same magnitude in different cases, and should not affect comparison of one animal with another. This is clearly an error in arithmetical procedure. The corrected ratio of the epidermal nuclei is 1 : 1·52 (= 1 : 1·87$^{2/3}$). If significant of anything at all, this suggests triploidy rather than tetraploidy. In controls, measurements of nuclear size in one tadpole gave a ratio quoted as 1 : 1·51, from which triploidy was inferred; the correct figure here is 1 : 1·31, and is thus rather less close to the 1 : 1·50 ratio expected for a triploid. Häggqvist claims that the alleged triploids and tetraploids of the frog are giant forms. This conflicts with all the literature on the subject of size of polyploid Amphibia (possible minute differences excepted), and is to our personal observation untrue for triploid tad[illegible]f *Rana temporaria* (unpublished experi[illegible]r. R. Douglas). Häggqvist describes [illegible]unate circumstances, including loss of [illegible]rols, that had hampered the progress [illegible]f the work. We have, therefore, to

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CONTROL IN NATIONALIZED INDUSTRIES

THE importance of obtaining a solution of the problems of public accountability of the nationalized industries has been repeatedly emphasized in recent debates in Parliament, notably in that on Lord Lindsay of Birker's motion in the House of Lords on July 5. It is discussed at some length in the April–June issue of *The Political Quarterly*, almost the whole of which is devoted to an examination of the nationalized industries. While the criteria for the efficiency of a nationalized industry must necessarily be broad, the distinction between a solvent and an insolvent nationalized industry cannot be ignored. The taxpayer or his representative has an indisputable right to consultation before commitments (whether in wage increases or in any other way, which involve further claims on his purse, such as operating losses or increased fares) are made by an insolvent industry. In the coal industry and in the steel industry, recent emphasis has been mainly on the efficiency aspect, and, while public accountability is no less important, it is essential that it should not operate in such a way as to impair efficiency. That might well be the effect of clause 10 of the Liberties of the Subject Bill introduced into the House of Lords by Lord Samuel, which received its second reading on June 27. The clause is intended to strengthen ministerial and, in consequence, Parliamentary control over the boards of nationalized industries and services; but it would appear to permit detailed interference of a kind unlikely to do much good without at the same time making the business management of the industries more inefficient. Although Lord Samuel proposes for general adoption a practice adopted for the Port of London Authority in 1908, Lord Hall was on much stronger grounds in objecting to it on behalf of the Government than either he or the Lord Chancellor were in rejecti some of the other clauses.

The series of articles in *The Political Q* represents one of the most useful contrib traditional defects of monopolies; if they excel in applying scientific research and development, then in due course an ever-increasing proportion of the nation will accept public enterprise as a wise method of conducting a larger share of the economy. But if the public corporations show themselves to be merely vast vested interests sheltered from direct parliamentary control, seated comfortably on their monopolistic positions and inflexible in outlook, the idea of public enterprise, in its present form, is likely to be rejected."

These are large questions; but answers must be found to them if the national, as distinct from sectional, interest is to be served.

The first three papers are concerned essentially with problems of organisation. Mr. D. N. Chester deals with the organisation of the nationalized industries specifically under that title; but Prof. W. A. Robson's discussion of the governing board of the public corporation and Mr. E. Davies's review of ministerial control and parliamentary responsibility of nationalized industries are no less concerned with organisation, particularly as it bears on the central problem of public accountability. Mr. Davies's article, it should be noted, was written before he became Under-Secretary of State for Foreign Affairs.

Although there is no standard form of public corporation, the main weaknesses due to organisation in the nationalized industries arise from the lack of clear division of responsibility between the Minister and the board. This, as Mr. Chester points out, is likely to cause confusion in the public mind and may lead to duplication of administrative effort. More important, it confuses the issue of public accountability, by making the evasion of responsibility easier and increasing the difficulty of securing public discussion. Even if the correct balance between interference and the autonomy of the public corporation has not yet been struck, too much appears to depend on ministerial predilection or idiosyncrasy.

Granted that each undertaking or industry must
sidered on its own, and that there is no one
of organisation suitable for all, especially
er atten is given the size of the

importance of solving the problem of
relations between the workers and the diffe
of management, and the importance of d
consultative machinery at all levels. He
that the boards are fully alive to these diffic
are giving them much attention. It is pr
his view, that the national boards may
concentrate more and more on general polic
substantially all operating responsibility to
or local level. Mainly they may find th
concerned with negotiations on aspects of w
conditions which have to be settled nation
approval and co-ordination of the plans fo
development and re-organisation, large-scale
projects, provision of certain services, settle
price policy, making of senior appointments
with the Government, and the general
and co-ordination of the work of the o

Mr. Chester is clearly doubtful as t
of one national board owning all the
industry and publicly responsible for all
Some functions, he considers, could be per
a central council; but others, such as approva
development programme and keeping the acti
of area units in line with national policy, shou
the responsibility of the Minister, provided wit
necessary advisory staff. A clear conceptio
ministerial responsibility for the exercise of p
control directly over the boards, for approving
general lines of the capital development, etc.,
grammes, and for the collection and publicatio
statistics permitting public judgment of the progres
and efficiency of the different boards, is the first ste
towards dealing with the question of public account
ability with which Mr. Davies's paper is particularl
concerned.

Mr. Davies points out that the considerab
ministerial influence over the public corporations
exercised largely behind closed doors, and, in cons
quence, ministerial responsibility tends to be evad
Mr. Davies favours more active intervention
Ministers and a greater degree of responsibility
their part to Parliament for the nationalized in
He seems, however, to admit rather exces
tary question, to an ext
encroach on the administra
d sacrifice the advan

Robson's article is concerned particularly
type of men and women serving on the
f nationalized industries. A clear definition
on and responsibility is important if we are
the services of the right type of men or
and while Prof. Robson holds firmly that the
nent of boards should be left to Ministers,
not regard all the actual appointments as
ry. He challenges as wholly mistaken the
on of a board as the meeting-place for the
tatives of interests, and suggests that
rs have too rarely shown themselves willing
to back their own judgment, even if it means
a risk, rather than appoint men almost *ex*

Robson recognizes the peculiar difficulties of
situation, and that in time we may
type of directing head, differing in
methods from any of those to which we
med in public administration or private
. Some of the new men who will direct the
corporations in the future will have been
ing and grown up in nationalized industries
selves. Here it will be necessary to avoid
eeding', and Prof. Robson urges the encourage-
of mobility between the corporations. Even
opportunities for gaining wide experience in
onalized industry, some members will be required
to have worked in different fields, and Prof. Robson
s great stress on the profound and fundamental
portance of upholding and enhancing the prestige, status and dignity of the posts. This consideration over-rides all those other considerations such as that of a policy rather than a functional board, and the right balance of full-time and part-time members; it is only in this way that we can hope to secure at the summit of the public corporations the men of
enius and energy whose guidance is essential for the
uccess of the industries concerned.

The composition of the national boards has likewise
most important bearing on the labour and staff
oblems under nationalization, which are discussed
Prof. G. D. H. Cole. Without the right men and
men at the top we are unlikely to see the right
sonnel policy, on which, more than on any other
tor, the ultimate success or failure of nationaliza-
probably depends. Unless public corporations
lic service motive throughout their
waken incentives of a new
from public ownership are
s with optimism on the
relations in the coal
, though he recognizes
technical and human
as recruitment and
problems; and he
industries are to be
er conditions of full
ion of the workers and of
t be enlisted on the side of
. their traditional attitude of
ment overcome.

e, bears directly on the further
iciency under nationalization and its measurement, the price policy of public corporations and the voice of the consumer, to which three further articles, by Prof. P. Sargant Florence and G. Walker, Prof. W. A. Lewis and Mr. J. A. C. Griffith, are concerned. These aspects received prominence in the debate in the House of Lords on July 5, though without contributing much towards a solution. For all that was said about the responsibility of the consumers' councils, there was little constructive thought about their real relations with the boards at the national or area level, and in particular whether they are not at present doing work which would more effectively or efficiently be carried out by public relations officers, although a reference in Lord Lindsay's speech suggests that the latter point may have been in his mind.

It was clearly recognized by Lord Pakenham that the consumer councils are not fully effective; but the question was not fairly faced whether they are doing, or are even able to do, anything that could not be done in other ways. Nor was the alternative suggestion that such councils might be established on a regional basis and not on the basis of a particular industry or service, to cover the consumers' needs in the nationalized industries as a whole in a particular region, really debated. The right kind of organisation, as Lord Lindsay of Birker suggested, is one inspired by the scientific spirit; but that organisation will only be attained as the result of a scientific and impartial exploration of the whole field of possibilities.

The crucial questions of the nationalized industries are admirably brought out by Sir Arthur Salter in the concluding article. On the administrative side these are really three. Two of these have already been noted: How can the incentives of competition, with prospective profit or bankruptcy, which are found in private enterprise, be replaced, and what safeguards can be found against the inherent tendency of bureaucracy to excessive centralization? Sir Arthur does not think that they have yet received the attention they demand, although it is evident from what was said in the House of Lords debate and in the articles already noted that they are now being seriously examined.

It does not appear to be appreciated as yet, however, as Lord Lindsay pointed out, that any effective Parliamentary control demands a high degree of centralization. Much more thought will clearly have to be given to the manner of decentralization as well as to the definition of the respective functions of the boards and the Ministers if this problem of accountability and efficiency is to be solved with due regard alike to the interests of the consumer and of those employed in the nationalized industries. Here we are confronted, too, with the third problem to which Sir Arthur referred—that of the adjustment of collective bargaining to the different conditions of nationalized monopolies.

On that issue Prof. Cole had little to say; but Sir Arthur indicated the seriousness of the issues which require examination and gives just a hint of the problems for the professional man to which Prof. J. W. Cook alluded. Sir Arthur clearly regrets that some of these problems were not faced and investigated before the latest experiments in nationalization were started, because we would then have had tentative policies, already studied and critically discussed, ready to be tried in practice.

The discussions during the past few months in various places of the activities and prospects of the nationalized industries in Britain are all to the good. They indicate, to an encouraging extent, a new disposition to re-examine the whole organisation and functioning of the industries without the strictures of party bias, and to consider in the light of actual experience how inherent dangers can be minimized or even avoided, and the arrangements for safeguarding efficiency and the public interest continuously improved.

A NOTABLE NEWTON COLLECTION

A Descriptive Catalogue of the Grace K. Babson Collection of the Works of Sir Isaac Newton and the Material relating to him in the Babson Institute Library, Babson Park, Mass.

With an Introduction by Roger Babson Webber. Pp. xiv+228+20 plates. (New York: Herbert Reichner, 1950.) 10 dollars.

IN 1710, at the age of sixty-seven, Isaac Newton moved into a house in St. Martin's Street, nearly opposite the present office of *Nature*, which he left in 1725, about two years before his death, for Kensington, in the hope that the pure air of that village, as it then was, might be better for his lungs. The St. Martin's Street house was demolished in 1913, but the dismantled fabric was saved by private action and eventually the complete woodwork of a parlour passed into the hands of Mrs. Babson, who used it to erect in the Babson Institute at Babson Park, Massachusetts, a replica of the original room. Great pains have been taken, by the installation of appropriate furniture, to give the room the appearance which it had in Newton's time. This, however, is only one expression of the Babson interest in Newton and his works. Mrs. Babson has assembled a very extensive collection of books by and about Newton, which she has supplemented by manuscripts from his hand, portraits, medals and such-like relics. The descriptive catalogue of this collection, which has just appeared, makes particulars of it accessible for the first time to students of Newton. It is an extremely handsome piece of book-making, which will be examined with interest by the cognoscenti.

This catalogue gives a literal transcription of the title-page of each book listed, a full collation, a short description of the binding and notes, in many cases taken without change from Sotheran's catalogues. The description of the binding reveals what is, in my experience, a surprisingly high proportion of original "Cambridge calf", a little-used term for calf with a rectangular panel of calf of a different colour. The transcription and collation appear to have been most carefully done—and book collectors will know how to value this. The notes, however, occasionally leave something to be desired. For example, in the short section "Collected Works", we find the three volumes of the "Opuscula", 1744, correctly listed, but described as "part of a set of 8 volumes of Newton's works collected and edited by . . . Castillioneus", with the brief titles of the "missing 5 volumes of th [illegible] set". But there is no uniform eight-volume editio [illegible] with one editor, such as is suggested. The entry i [illegible] Gray's "Bibliography", which has presumably misle [illegible] the compilers of this catalogue, prints the title-pag [illegible] of the "Opuscula" with the word "Opera" erroneous [illegible] substituted for the word "Opuscula". To make u [illegible] the eight volumes of the "Principia", 1739–42, [illegible] have to add to the "Opuscula" not only the "Optic [illegible] of 1740, which had the same publisher but a differe [illegible] editor; and the "Arithmetica Universalis", which [illegible] is true, had the same publisher and editor, [illegible] appeared in 1761, some twenty years later, in t [illegible] volumes, often bound as one: but also the so-call [illegible] "Jesuits' edition" of the "Principia", 1729–42, t [illegible] editors of which, Le Seur and Jacquier, were [illegible] Jesuits but Minims (an order founded by St. Fran [illegible] of Paula, which never had houses in England [illegible] edition, in three volumes, sometimes bou [illegible] has a different publisher. It is listed [illegible] the catalogue before us and so is no [illegible] There is no evidence that the different [illegible] and editors issued the works with the view [illegible] a complete edition of Newton's works: th [illegible] uniformity of editing or publishing. It is tim [illegible] the matter were made clear, and if there is, unknown to me, any "collected edition" edited by Castillioneus I hope that this declaration of opinion will bring it to light.

The notes on Voltaire's "Elémens de la Philosophie de Newton" also call for comment. They quote the phrase on the title as "Mis à la portée [porte] de tout le monde", which seems to suggest that "portée" was a misprint. It is, of course, correct—"brought within reach of everyone's comprehension". To change the word to "porte"—"shown the door by everybody"—is to perpetuate the jeer of contemporary wits. And to say of an edition of 1822, "In this last edition, wholly rewritten by Voltaire, first appeared the well-known story of the falling apple", suggests that Voltaire was still active at the great age of 128. Actually the falling apple story was printed in Voltaire's "Lettres sur les Anglais", 1733, of which the English translation, of the same year, is listed as item 242 in the volume under notice, and also in the second edition of the "Elémens de la Philosophie" of 1741, although not in the first.

The collection is a magnificent one, containing rarities, but there are many strange gaps which could be easily supplied. There is, for example, no copy of Harris's "Lexicon Technicum", in which Newton's important "De Natura Acidorum" first appeared, nor of the diary of Abraham [illegible] a contemporary of Newton's, i [illegible] known anecdotes of Newt [illegible] There is a lack of books w [illegible] work at the Mint, such [illegible] Pound". The Royal S [illegible] tions Volume of 1946 [illegible] The Russian collectio [illegible] by Vavilov, is listed [illegible] Vavilov or the Russ [illegible] Opticæ"—the only t [illegible] into a living tongue [illegible] time. The edition of Au [illegible] a bad one, marred by bl [illegible] good edition, and all the ot [illegible] except perhaps, at the present [illegible] —as well as certain other missi [illegible] procure. Not so easy to find, perha [illegible] and some other of the omissions w [illegible] noted; but it seems a pity that so extensive a collection should have such notable gaps.

Reference must be made to the many books from Newton's library, to the noteworthy Newton manuscripts and to the many portraits in the collection, including what is apparently a fine copy of the Vanderbank portrait in the National Gallery.

The appearance of this catalogue is another sign of the informed and enthusiastic interest in Newton which is taken in the United States at the present time. The best life of Newton now available is that by L. T. More, of Cincinnati. Marjorie Nicolson's recent "Newton Demands the Muse" was an original study that gave much pleasure to students of Newton. If we have felt bound to animadvert upon certain from among the small blemishes noted in this Catalogue, nevertheless nothing set down here must be allowed to obscure the fact that this volume is a noteworthy record of a collection of great interest, which any Newton bibliophile will be glad to possess.

E. N. da C. Andrade

TUNICATE BIOLOGY AND DEVELOPMENT

The Tunicata

With an Account of the British Species. By Prof. N. J. Berrill. (Ray Society Vol. for the Year 1946.) Pp. vii+354. (London: Bernard Quaritch, Ltd., 1950.) 27*s*. 6*d*.

THE appearance of Prof. N. J. Berrill's work on the tunicates is a major event for students of the group. It brings together in convenient form the results of researches by European and American workers, leavened throughout by the very substantial contributions of the author.

The book is divided into two parts, dealing respectively with the sessile and pelagic tunicates. Each part begins with a well-documented general account, followed by a synopsis of the classification with a key to the families, and, finally, by a detailed and generously illustrated account of the British species. There is a synopsis of the genera in each family, but no key to the species. This will be a disappointment to biologists unfamiliar with the group, and students must still be referred to the key given by Huus in "Die Tierwelt der Nord und Ostsee"; by a curious oversight this is not listed in the bibliography.

The treatment of the Didemnidæ is rather sketchy. The author does not refer to ten of the twelve species of *Didemnum* described in the "Faune de France", a good proportion of which, if they be confirmed as separate species, might be expected to occur in Britain; but he includes, without comment, *Didemnum gelatinosum* and gives only a very brief description of *D. maculosum*. It is by no means certain that there is such a species as *D. gelatinosum*, while *D. maculosum*, as generally recognized, includes several varieties, some of which may be accorded specific rank when more precise characters for their determination have been worked out.

In the Polyclinidæ, the author grasps the nettle more firmly and, amalgamating *Aplidium* and *Amaroucium*, discards *A. roseum* and *A. albicans* as varieties, but includes both *A. proliferum* and *A. nordmanni* and also *A. densum*. Ascidian systematists have so far failed to deal successfully with these two groups, and further progress will depend upon a careful study of the range of variability of each so-called species. In the account of the sessile ascidians, the sections on development are outstanding and are illustrated by a fine series of figures mainly from the author's publications.

The account of the pelagic tunicates is not so complete, and many of the illustrations are too small to be of real value in diagnosis. One new generic name, *Haplopleura*, is introduced for a form that is not British; a separate publication of this new name would have been advisable.

Throughout the book many of the figures reproduced from other works have been reduced and have suffered in consequence. A tendency to group too many drawings in one figure also occurs repeatedly. Errors in the text appear to be few, the worst I have noted being the sadly garbled spelling of *garstangi* in the legend to Fig. 19. The bibliography has not been so carefully checked and mis-spellings are rather numerous; there is also an error in the list of contents.

The style is eminently readable, which in itself greatly increases the value of the work; very frequently the author points to gaps in our knowledge where further research is needed. Finally, I must refer to the most remarkable feature of the book, the fact that it has been written by a busy professor of zoology at a large Canadian university; this is indeed proof of scholarship.

H. A. Cole

THE NEW VISION

Electron Microscopy

Technique and Applications. By Ralph W. G. Wyckoff. Pp. ix+248. (New York and London: Interscience Publishers, Inc., 1949.) 40*s*.

DR. WYCKOFF has achieved the sort of thing that several of us must have turned over in our minds and hoped perhaps to be able to settle down to one of these days, and we should wish to congratulate him on that in any case. He has done it exceedingly well, too, which is more to the point, and has thereby earned our thanks besides. We should have been disappointed, though, if it had turned out otherwise, for every electron microscopist knows of the industry, experience and experimental skill of R. W. G. Wyckoff.

There is, of course, a fair variety of articles and books on electron microscopy available already, and together they cover a lot of ground; but, all the same, this one is something different. The book has a relative simplicity and wide appeal which make it rather the story of the new field of vision; it contains plenty of instruction and workaday 'tips' for specialists but keeps up a fascination that many others, concerned only indirectly with particular techniques, will find irresistible. The text is authoritative but friendly, and all the time there is the background of collaboration and of the tremendous reaches still waiting to be explored. The author says, "The possible fields of application of an instrument which extends the range of our perceptions as much as does the electron microscope are so numerous, and so unpredictable, that little can be done at this early date besides indicating the kinds of objects that can be examined and the new techniques that are needed for this purpose"; but that is just what was wanted, and wanted in this kind of way, because electron microscopy is not simply a triumph of electron optics but, in its applications, almost everybody's subject—and especially now that it has penetrated down to the molecular level, to the new underworlds of visual crystallography, visual chemistry and the like.

To-day we are recapturing with visible molecules the historic thrill that must have been experienced by Leeuwenhoek when first he perceived his "little animals". His creatures have become the monsters of our underworld, and indeed they have grown so big that we are now struggling with the problem of how best to break them down into authentic components sufficiently small for electron microscopy.

It is a pity to have to find fault in any way with this worthy effort of Dr. Wyckoff's, or rather the outcome of it; but it has to be admitted that the reproductions of his electron micrographs are scarcely as good as is required to realize to the full the inspirational value of the text. There are 202 illustrations, which means that the work is also by way of being an atlas of electron microscopy, with all the responsibility that implies. The non-specialist reader will probably judge the pictures excellent, and so they are as text-book reproductions usually go; but those who are acquainted with the great beauty and detail of some of the originals are bound to heave a sigh, and even those who are not will be puzzled sometimes to pick out what is being described. Undoubtedly it is a matter of expense, since £2 is already a substantial price for what is, after all, not a very fat book.

There is an extensive bibliography, arranged chapter by chapter. There are not many printer's errors, but a peculiar spelling aberration (also in the index) is "comma" for the optical aberration 'coma'. Occasionally, as in the legend to Fig. VIII, 1 ("Chick embryo cultured elementary bodies of a strain of psittacosis virus, etc."), there are constructions to which some of us in Britain still do not take very kindly; but that is a question of taste, or perhaps only conservatism.

W. T. Astbury

OUTLINE OF MATERIALIST PHILOSOPHY

Philosophy for the Future

The Quest of Modern Materialism. Edited by Roy Wood Sellars, V. J. McGill and Marvin Farber. Pp. xiv + 657. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1949.) 37*s*. 6*d*. net.

THE general view of the authors of this ambitious and competent work is that the power and capacity of a materialist philosophy have never been satisfactorily assessed, especially in relation to contemporary and future needs. Even without necessarily endorsing every aspect of this outlook, it is natural to extend a welcome to this book, and to see in it a solid contribution to its own particular branch of knowledge. The impression it gives—not so much in detail as in the manner of its broad sweep—is of a co-operative effort specifically designed for an American public, and one likely to win attention and hold it in the characteristic philosophical 'climate' of the United States.

With an array of some thirty contributors to consider, it is evidently unprofitable to select passages here and there for comment; better, it would seem, to attempt some assessment of the pattern as they have woven it. Thus a series of historical chapters comes first, followed by a set dealing in detail with outstanding examples of the materialist position to-day; and lastly, and perhaps the most valuable, several articles descriptive of divergent systems of thought, so divergent in fact as, for example, logical empiricism and Neo-Thomism—and all this with a common aim, kept in reasonably sharp focus.

A good feature is the way in which definite points are allowed to emerge. An illustration of this is the fervent desire of the Vienna Circle and their successors to banish metaphysics, and to make everything depend upon criteria of verifiability; as is well and truly remarked, rejection or denial of something is utterly different from 'really' getting rid of it—theories of Being are not liquidated so easily as that.

To some minds, maybe, these pages will raise more questions than they answer; it is probably well that they should. Philosophy, after all, is quite as intent upon realizing problems as in solving them.

F. I. G. Rawlins

WILD ANIMALS IN BRITAIN

Wild Animals in Britain

Mammals, Reptiles and Amphibians. By Oliver G. Pike. Pp. xii + 231 + 8 plates. (London: Macmillan and Co., Ltd., 1950.) 18*s*. net.

THE mammals of the British Isles do not make a long list; but it is a highly interesting one. On this list are found many species and subspecies that show differentiation and peculiarities due to isolation on islands. We appear to have new species in the making, this evolution proceeding under our eyes.

"Wild Animals in Britain", by Mr. O. G. Pike, another volume of the Macmillan series that deals with the British fauna and flora, covers the mammals, reptiles and amphibians and their island races.

Mr. Pike is well qualified to write on this subject, having a wide experience of British wild life, and he does so lucidly and entertainingly, giving much information that will be helpful to those interested in this branch of our fauna.

The reviewer, having a special interest in rodents, would have liked more space devoted to such small mammals as the unique Skomer vole, *Clethrionomys skomerensis*, found only on the six hundred or so acres of rocky island off the Pembrokeshire coast; but this book is a balanced survey, not an exhaustive account of any particular creature, and it admirably fulfils its purpose.

We must regret that it was not possible to include some account of certain domestic or semi-domestic animals, for example, the so-called wild white cattle, and the Chillingham herd of them in particular. These cattle are of considerable interest, being a perpetuation of a primitive type once no doubt plentiful in these islands.

But such remarks are ungrateful where so much has been given the reader, and given so charmingly.

The illustrations consist of colour plates, being reproductions of sketches, including the frontispiece from a painting by Mr. William Reeves, and a number of excellent photographs. A striking snapshot is that of a mountain hare in its form in a snowdrift by the late G. B. Kearey, and striking, too, is the photograph of a wood mouse by Dr. M. S. Wood.

Frances Pitt

Contributions to American Anthropology and History

Vol. 10, Nos. 48–51. (Publication 585.) Pp. v+186+17 plates. (Washington, D.C.: Carnegie Institution, 1949.) 4 dollars.

OF the four contributions in this volume, three deal with the Maya and the fourth with the south-west region of the United States. The first, No. 48, "The Maya Chronicles", by Alfredo Barrera Vásquez and S. G. Morley, treats of Maya history as set forth in chronicles, which have come down to us in five of the books called "Chilam Balam". These have survived in the form of seventeenth- to nineteenth-century copies of the MSS. written in Spanish characters in the Maya language, but are partly based on old hieroglyphic codexes, now lost. Mr. Barrera Vásquez has collated these sources, amending the order in some cases, and has produced an outline of the history of the Maya in northern Yucatan from the fifth to the seventeenth century. Dr. Morley adds a commentary, giving his own views of Maya history in the light of Mr. Barrera Vásquez's work. Much of this will be familiar to readers of his general work, "The Ancient Maya"; but it is valuable to have this fuller version. This contribution is of importance to all who are interested in the Maya; but the other two, by R. L. Roys, will appeal mainly to specialists.

No. 49, "Guide to the Codex Pérez", is a study of extracts made in the nineteenth century by Juan Pío Pérez from some of the books of "Chilam Balam", and No. 51, "The Prophecies for the Maya Tuns or Years in the Books of Chilam Balam of Tizimin and Mani", is a text and translation, with introduction, of the appropriate parts of those books.

Contribution No. 50, "The Pendleton Ruin", by A. V. Kidder, H. S. and C. B. Cosgrove, is an account of an excavation of a site in the extreme south-west of New Mexico belonging to a marginal variety of the Casas Grandes culture of Chihuahua, Mexico, with mention of a reconnaissance of some neighbouring sites. The work was done in 1930 and 1933, and publication has been delayed by various causes, including the death of Mr. Cosgrove. The site gave rise to the definition of the Animas Phase of the Casas Grandes culture, which is mentioned in the publications of H. S. Gladwin and others. The importance of the work lies in this and in the lack of previous work in the area.

Introduction to Chemical Thermodynamics

By Prof. Luke E. Steiner. (International Chemical Series.) Second edition. Pp. xiv+510. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

IN this second edition of his book, Prof. L. E. Steiner has added some new material and has modified the arrangement somewhat. The section on statistical methods has been expanded into a very clear and useful chapter. The whole text is sufficiently detailed to meet the needs of all kinds of students of chemistry, and the book contains an unusual amount of information for a volume of its size.

The author has shown both originality and skill in the development of his subject. In the treatment of the First Law of Thermodynamics, energy is taken as something known, and heat and work are considered as secondary quantities in relation to it. This leads to some obscurity when the Second Law comes to be treated. The introduction to the Second Law is very clear and informative. The entropy is introduced as the coefficient of the temperature differential in the energy expression, after the manner of Gibbs; but its properties are fully developed later. This treatment, in the reviewer's opinion, leads to difficulty in relation to isothermal changes, which are particularly important in chemistry; but, apart from this, no objection can be taken to the method used by Prof. Steiner.

The applications of thermodynamics are dealt with in a very sound and detailed way, with full use of numerical data and close attention to units. There are many good numerical problems. This is a very sound and attractive book and can be recommended without reserve. J. R. P.

Alkylation of Alkanes

By Gustav Egloff and George Hulla. Vol. 1: Patents on Alkylation of Alkanes. (American Chemical Society Monograph Series, No. 107.) Pp. xiv+1138. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 120*s*. net.

THE chemistry of the paraffin hydrocarbons has grown enormously in recent years, chiefly owing to the study of these hydrocarbons present in petroleum. The alkylation of alkanes is of particular importance, as it is a reaction which enables one to produce branch-chain products from straight-chain hydrocarbons. This reaction thus gives a very valuable improvement in the ignition qualities of fuels for spark-ignited internal-combustion engines.

The book is the first of a three-volume treatise on the alkylation of alkanes and consists of a description and a discussion of the various patents which have been issued on this subject. Catalytic alkylation is dealt with, consideration being given to various catalysts which have been used for this purpose. There is a section dealing with the thermal alkylation of alkanes, and reactions involving the removal of alkyl radicals are also discussed.

In the two volumes to follow, it is proposed to deal with the scientific and technical publications on this subject, particularly the reports on work carried out by the oil companies during the Second World War. The complete work should be of great value as a standard reference on this subject, and will save workers in this field many hours of searching through the literature. W. W. G.

Philosophy of Nature

By Moritz Schlick. Translated by Amethe von Zeppelin. Pp. xi+136. (New York: Philosophical Library, Inc., 1949.) 3 dollars.

MORITZ SCHLICK was a leader, if not the leader, of the philosophical school known in the 1920's as the Vienna Circle. He was assassinated while on his way to lecture—an unusual death for a professor. This was in Vienna in 1936, and the assassin was a lunatic.

The book consists of an outline of a course of lectures on the concepts of natural science, compiled from MSS. left behind by Schlick. The treatment of physical concepts is clear, eminently reasonable, but elementary and much too summary. The treatment of biological concepts is perfunctory. It looks as though little of the interest of the lectures has survived in the book; a better idea of the quality of Schlick's thought can be gathered from the discussion in an appendix on "The Concept of the Atom". The publication of this book is evidently intended as an act of piety by some of Schlick's friends—a somewhat misjudged piety. A. D. RITCHIE

SYNTHESIS OF PEPTIDES IN ENZYMIC REACTIONS INVOLVING GLUTATHIONE

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FEW biological problems are of such basic interest as the elucidation of the process whereby proteins are synthesized in the cell. Despite much inquiry, however, the nature of the mechanisms involved remains obscure. Since the amino-acid residues in the protein molecule are linked together mainly by peptide bonds, the mechanism of formation of these linkages constitutes an important part of the problem as a whole.

Studies of the metabolism of 'labelled' amino-acids have shown that the proteins in living organisms are undergoing continuous breakdown and re-synthesis[1]. It is usually assumed that the down-grade process consists of hydrolysis of peptide bonds catalysed by the proteolytic enzymes; the nature of the up-grade reactions leading to the synthesis of peptides, on the other hand, has been the subject of varied speculation.

The purpose of this communication is to describe an enzymic reaction in which peptides are formed by interaction between free amino-acids and the tripeptide glutathione. The possible significance of reactions of this new type, which will be termed 'transpeptidation' reactions, can best be judged from a brief consideration of current knowledge of the subject.

Views on the Synthesis of Peptide Bonds

A hypothesis of long standing is that synthesis of peptide bonds is the result of direct condensations between carboxyl and amino-groups, in reactions which are the reversal of hydrolysis and accordingly catalysed by the proteolytic enzymes[2]. Since equilibrium between a peptide and its split products lies far on the side of hydrolysis, appreciable synthesis could occur only if the peptide were removed effectively from the system as it was formed. Bergmann and Fruton[3] recall that various proteolytic enzymes were shown to catalyse condensation as well as hydrolysis by allowing them to act upon amino-acid derivatives which yield insoluble peptides; they stress further that the sharp specificity of the proteolytic enzymes lends plausibility to the view that they may play an important part in protein synthesis, since some such specificity must be assumed to be operative during the formation of the peptide-chain structure of proteins.

According to other hypotheses, the chemical pathway of synthesis of peptide bonds is distinct from mere reversal of hydrolysis, and a variety of intermediates have been suggested, more or less tentatively, by different authors. These include: keto-aldehydes[4], acid amides[3], acyl phosphates[5], acetyl amino-acids[6], and esters of amino-acids[7].

The probable importance of mechanisms involving acyl phosphates as suggested by Lipmann[5] is evident from the discovery of three different enzyme systems in which condensations between carboxyl and amine groups take place with concomitant breakdown of adenosine triphosphate. These reactions lead to the formation of peptide-like linkages, but in no case as yet to normal peptide bonds between two alpha amino-acids; they are (*a*) the acetylation of aromatic amines by acetate and adenosine triphosphate[8], (*b*) the formation of hippuric acid from benzoic acid, glycine and adenosine triphosphate[9], and (*c*) the synthesis of glutamine, which will be discussed separately.

Glutamine and Glutathione

The enzymic synthesis of glutamine was achieved in the important studies of Speck[10a,b,c] and Elliott[11], who discovered an enzyme in animal tissues which catalyses the following reaction:

$$\text{glutamic acid} + NH_3 + \text{ATP} \rightarrow \text{glutamine} + \text{ADP} + \text{free P}.$$

Ammonia can be replaced in the reaction by hydroxylamine[10c,11], methylamine or hydrazine[10c], yielding the corresponding substituted amides. A similar enzyme is now known to occur in bacteria and in higher plants[12a,b].

Apart from the reaction leading to glutamine formation, it has been shown by isotope studies that, in the absence of adenosine triphosphate, the amide group of glutamine is exchanged with free ammonia in the presence of an enzyme from plants[13], and with hydroxylamine in the presence of enzymes from plants[13,14], animal tissues and bacteria[15]. Similar enzymic 'transfer' reactions involving asparagine have been described[15].

The close physiological connexion between glutamine (and asparagine) and the metabolism of nitrogen in both plants and animals lends great interest to these discoveries. Attention turns also to other naturally occurring γ-glutamyl compounds of which glutathione is best known. This tripeptide γ-glutamyl-cysteinyl-glycine, is widely distributed and occurs in relatively high concentration in actively growing tissues.

Various views have been advanced as to the physiological role of glutathione; but latterly emphasis has been placed upon a possible connexion with protein/amino-acid metabolism. Waelsch and Rittenberg[16], for example, suggested that glutathione may act as an intermediate between free amino-acids and proteins. Much work has been directed to the problem of the synthesis of glutathione as a model for peptide synthesis; the incorporation of 'labelled' glycine into glutathione has been used as an index of synthesis in these studies, and such incorporation has been found to occur in liver slices, homogenates and certain cell-free extracts[17,18,19]. It has been established that the rate of incorporation of glycine is increased by addition of adenosine triphosphate[19], and quite recently, of various amides including glutamine[20]. Such studies have not as yet revealed the precise nature of the reactions involved in the synthesis of glutathione; and, it should be mentioned, the existence of transpeptidation reactions of the type to be described below may well complicate the interpretation of results based solely upon determination of rates of incorporation of 'labelled' glycine.

Possible Significance of Enzymic Transpeptidation Reactions

In planning investigations in this field, we were influenced by certain analogies drawn from the field of polysaccharide synthesis. The prominence of 'trans-glycosidation' reactions in the interconversion of various saccharides is well known, and this emphasized the desirability of determining whether corresponding enzymic reactions occur involving peptides. Such a 'transpeptidation' reaction would be pictured as a process of group transfer, without intervening hydrolysis, in which either the carboxyl- or the amino-moiety of an existing peptide would be transferred to linkage with the appropriate group of another amino-acid (or peptide) molecule. In this way a new peptide bond would be formed secondarily at the expense of an existing one according to either of the following general equations:

$$R^1.\mathrm{CONH}.R^2 + R^3.\mathrm{COOH} \rightleftharpoons R^3.\mathrm{CONH}.R^2 + R^1.\mathrm{COOH} \quad \text{(amine transfer)}$$

$$R^1.\mathrm{CONH}.R^2 + \mathrm{NH_2}.R^3 \rightleftharpoons R^1.\mathrm{CONH}.R^3 + \mathrm{NH_2}.R^2 \quad \text{(carboxyl transfer).}$$

If such enzymic transpeptidation reactions do, in fact, occur, they might clearly be of great importance in the synthesis of protein. Given a mechanism for the *primary* synthesis of a peptide bond, however limited the range of amino-acids which could thereby be linked together, it is possible to envisage a sequence of transpeptidation reactions leading to the *secondary* formation of a great variety of other peptides. It is conceivable that a regular order of occurrence of amino-acids in a chain structure could result from this process.

More detailed lines of speculation emerge when such considerations are applied to the specific findings and problems outlined earlier. It might be envisaged, for example, that relatively few mechanisms exist for the primary synthesis of peptide or peptide-like bonds, and that glutamine, and possibly in addition γ-glutamyl peptides formed in a similar way, are examples of such primary products. The secondary derivation of any particular peptide might then be pictured as involving any or all of the following transpeptidation reactions:

(*a*) γ-glutamyl-amide ⇌ γ-glutamyl-peptide (carboxyl transfer);
(*b*) γ-glutamyl-peptide 1 ⇌ γ-glutamyl-peptide 2 (carboxyl transfer);
(*c*) γ-glutamyl-peptide ⇌ α-peptide (amine transfer);
(*d*) α-peptide 1 ⇌ α-peptide 2 (amine *or* carboxyl transfer).

As an example of a type (*a*) reaction it would be possible to envisage the formation of glutathione by the transfer of the γ-glutamyl group from glutamine to cysteinyl-glycine (carboxyl transfer). The same tripeptide might be formed in other ways, for example, by the transfer of glycine from some suitable peptide to the carboxyl group of γ-glutamyl-cysteine (amine transfer).

In the course of a sequence of such reactions (whether *a* to *c*, *b* to *c*, or a sequence of type *d* reactions), the constituent groups of the first peptide would be set free. Thus re-synthesis of this peptide by a primary mechanism would permit the continuation of the process.

This speculative scheme formed the starting point of a series of investigations of which one result has been the demonstration that transpeptidation reactions of type *b* do, in fact, occur. Thus glutathione has been found to react with free amino-acids (and possibly other peptides) giving rise to other γ-glutamyl peptides.

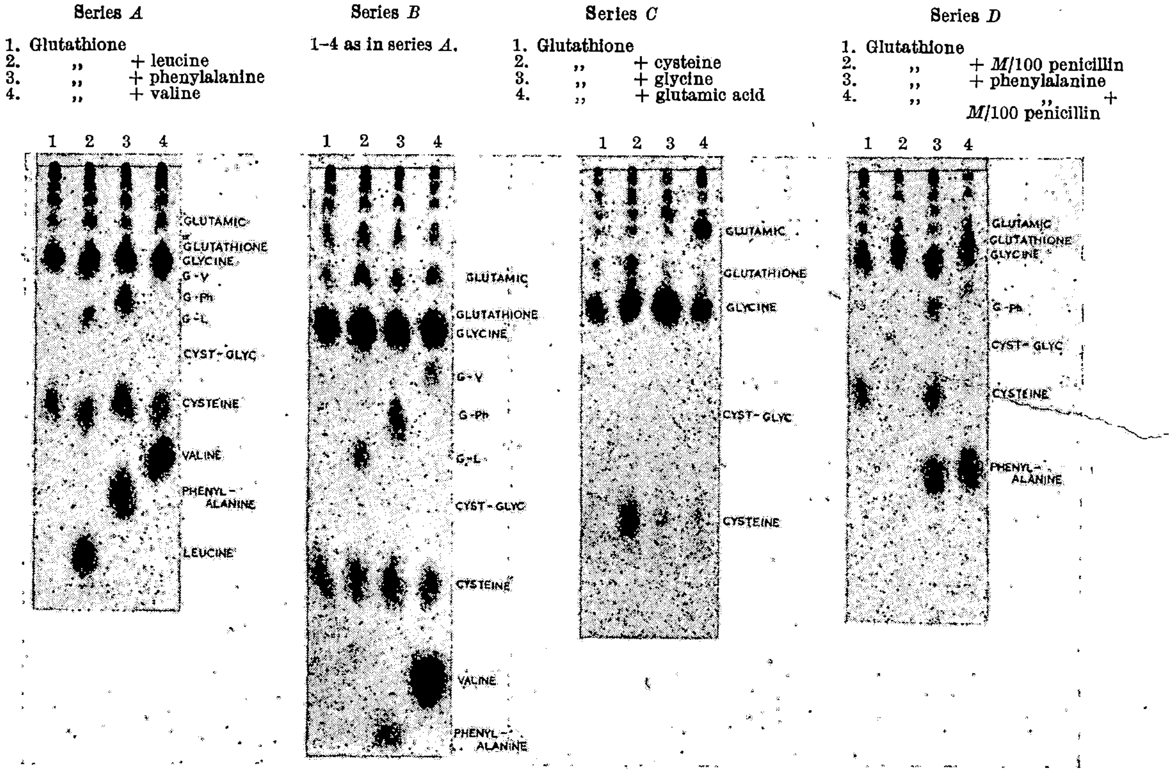
Demonstration of Transpeptidation Reactions involving Glutathione

Extracts of kidney and pancreas tissues are known to contain enzymes which act upon glutathione[21,22,23]; and the reaction has been pictured as a relatively simple process of degradation involving first the splitting of the γ-linkage to yield glutamic acid and cysteinyl-glycine, followed by hydrolysis of the latter[23]. This is undoubtedly an over-simplified picture of the complex reactions which occur in such systems.

In the present experiments, enzymes prepared from sheep kidney have been used. 6 gm. of fresh tissue are homogenized with 10 ml. $M/20$ potassium phosphate buffer at *p*H 7·4, containing $M/1{,}000$ magnesium ion. After centrifuging (15 min., 3,000 r.p.m.) the supernatant is dialysed against 1 litre of buffer for 4 hr. with stirring. In the typical enzymic digest, such extracts diluted to one-third original strength were allowed to act upon glutathione ($M/20$ final concentration) or glutathione ($M/20$) plus selected amino-acid ($M/20$) at 32° C.

Reaction was detected and followed by paper chromatography using Whatman No. 1 paper (either as supplied or after washing in *M* sodium carbonate followed by water) and for most purposes 80 per cent aqueous propanol as solvent. Cysteine and peptides containing cysteine presented chromatographic difficulties which were overcome by coupling with N-ethyl-maleimide[24] during the preparation of samples as follows: samples of digests (0·3 ml.) were treated with 0·6 ml. warm ethanol to precipitate proteins; the supernatant solution was evaporated in a desiccator and the residue taken up in 0·15 ml. $M/7{\cdot}5$ N-ethyl-maleimide in water[24]. The resulting solution was used for spotting on the chromatogram, using 1 μl.

Chromatograms illustrating the main points to be discussed are shown in the accompanying reproduction, those in any one series (for example, *A*, *B*, etc.) being comparable as to enzyme, paper, running-time, etc. In all cases illustrated, the enzymic reaction had proceeded 60 min. when the samples were taken. Control chromatograms of enzyme without additions of substrate showed no ninhydrin-reacting material; the various substrates were pure, and when run alone or with killed enzyme they gave compact spots in characteristic positions (except that glutathione on one batch of unwashed paper tended to give a double spot on prolonged running); an



CHROMATOGRAMS OF ENZYMIC DIGEST SAMPLES

Digests consisted of: kidney enzyme, ⅛ vol.; substrates as indicated added in *M*/20 final concentration; phosphate buffer *p*H 7·4—*M*/60. Samples prepared for analysis as described in text after 60 min. reaction at 32° C.
Chromatography: Solvent: propanol/water (80/20); papers: series *C*, No. 1 Whatman unwashed; series *A*, *B* and *D*, No. 1 washed in sodium carbonate; running times: series *A* and *C*, 19 hr.; series *B* and *C*, 43 hr.

identification mixture of glutamic acid, glutathione, glycine, cysteinyl-glycine and cysteine was run consistently on all papers, and the position of these substances is indicated beside each series. Oxidized glutathione ($G-S-S-G$) remains almost at the starting line on the chromatogram and could not be confused with the other substances to be discussed.

The complexity of the 'breakdown' of glutathione under the action of these extracts will be evident from chromatograms *A*1, *B*1, *C*1.

In each digest there remains only a small and somewhat variable spot of glutathione (see series *C*) and each shows a prominent glycine spot; a relatively small amount of glutamic acid has been liberated, and cysteine, ranging from a trace to a pronounced spot, is present. The striking feature of all cases, however, is the series of at least three substances which travel as compact spots more slowly than glutamic acid. Discussion of the nature of these substances is best deferred until the interaction between glutathione and added amino-acids is established. It should be mentioned that chromatograms of digest samples taken after shorter reaction periods showed more or less pronounced spots of cysteinyl-glycine, these diminishing and finally disappearing as the reaction proceeds.

In a series of four digests, the enzyme was incubated with glutathione alone, glutathione plus leucine, glutathione plus phenylalanine, and glutathione plus valine; analysis of these on carbonate-washed paper run for 19 and 43 hr., respectively, are shown in series *A* and *B*. The three amino-acids added were chosen because of their relatively rapid rates of travel, as will be seen from their positions on the chromatograms. (Leucine had run off the paper in series *B*.) In both series new spots intermediate in position between glycine and cysteine were present in digests to which amino-acids were added with glutathione; these new substances are different in the three cases, and it will be noted that they travel in the same relative order as the added amino-acids. (The new spot in *A*4 has scarcely separated from glycine; but a clear separation had occurred in *B*4.) The three new spots formed in these digests are believed to be, respectively, γ-glutamyl-leucine (*G-L*), γ-glutamyl-phenylalanine (*G-Ph*) and γ-glutamyl-valine (*G-V*).

The provisional identification of these substances formed by the interaction of glutathione with the different added amino-acids rests at present upon a closer study of the middle member of the series. Analysis of samples after varying periods of enzymic action show that the new substance increases progressively during the 60 min. of reaction period. Rows of spots of the new substance formed with glutathione plus phenylalanine as substrate were extracted from the paper; this extracted material was unchanged as regards its chromatographic behaviour. A portion was hydrolysed (6*N* hydrochloric acid, 105° C., 24 hr.) and the resultant solution was found to contain only glutamic acid and phenylalanine. Glutamic acid was then identified as the amino end-group by Sanger's method[25].

These various lines of evidence pointed to the new substance being either α- or γ-glutamyl-phenylalanine.

A specimen of the former dipeptide was prepared for comparison. The unknown, although similar in chromatographic behaviour in the aqueous propanol solvent, was not identical, and by using propanol/glacial acetic/water (80/10/10) as solvent a clear separation was obtained, the α-peptide travelling appreciably faster than the unknown (as would be expected on the basis of the *pKa* values of the two carboxyl groups if the unknown were the γ-peptide). A further important point of difference was that the α-peptide was broken down rapidly to glutamic acid and phenylalanine by the enzyme preparation. Pending the preparation of γ-glutamyl-phenylalanine for direct comparison, there thus seem good grounds for provisional identification of the unknown with this dipeptide.

In a further series of four digests of which the chromatograms are shown in series *C*, the enzyme was incubated with glutathione alone, and glutathione plus additions of each of its constituent amino-acids in turn. (These chromatograms were run with solutions of half the usual strength as this improved the definition.)

It will be seen that *C*4 shows not only the heavy spot of the added glutamic acid, but also a spot near the starting point which is much heavier than with glutathione alone. Similarly, *C*2, with added cysteine, shows not only a cysteine spot but also intensification of certain of the slowly moving spots. Finally, *C*3 shows that the effect of adding glycine is to increase strikingly the amount of the spot travelling immediately above glutamic acid.

These observations suggest strongly that the slowly travelling spots which appear when glutathione is incubated with the enzyme represent peptides formed by the interaction of glutathione with its different constituent amino-acids. Given any trace of amino-acids in the digest, it is probable that the transpeptidation reaction occurs, liberating cysteinylglycine, which is then split to cysteine and glycine. Further transfer of γ-glutamyl groups from glutathione to these amino-acids would then occur more rapidly. Since there are indications that these slowly moving substances may be more complex than dipeptides, no suggestions will be made as to their identity until quantitative analyses are available.

At the suggestion of Dr. E. F. Gale, a study of the effect of benzyl penicillin on the system has been made. Kimmel, Olson, Okeson and Binkley[26] have reported recently that the breakdown of glutathione in a similar enzymic preparation is inhibited competitively by benzyl-penicillin.

Series *D* chromatograms illustrate typical results. By comparing *D*1 with *D*2 (from digests with glutathione alone) and *D*3 with *D*4 (from digests with glutathione + phenylalanine) the following main effects of the addition of benzyl-penicillin will be seen: (1) the amount of residual glutathione is greater, thus confirming the conclusion of Kimmel *et al.* (*loc. cit.*); (2) the cysteine spot has largely disappeared, due presumably to the well-known reaction between cysteine and penicillin[27]; (3) two of the slowly moving spots characteristic of the breakdown of glutathione have virtually disappeared; (4) the formation of γ-glutamyl-phenylalanine is strongly inhibited.

These results suggest that the biological action of penicillin may be connected with the inhibition of γ-glutamyl transfer reactions; but, in addition, the combination of penicillin with cysteine would prevent the re-synthesis of glutathione from its breakdown products and so interrupt any cyclical process in which it is involved.

Mention should be made finally of experiments carried out with other types of enzyme preparation. Pig kidney, acetone powder from sheep kidney, and fresh ox pancreas were found to give active extracts. No detectable activity was found in extracts of liver.

Discussion

One of the four main types of transpeptidation reactions which have been postulated can now be said definitely to occur, and the participation of glutathione in such reactions has been demonstrated.

The exploration of other parts of the scheme of reactions relating to γ-glutamyl compounds is in progress, and it remains to be seen whether, on one hand, there is a direct biochemical connexion between glutamine and glutathione and whether, on the other hand, γ-glutamyl peptides may be converted further into α-peptides as a result of 'amine transfer' reactions.

In the meantime, attention may be directed to the striking fact that, not only is the γ-linkage itself stable against the action of peptidases present in the extracts used, but also the presence of the γ-glutamyl group in glutathione renders the cysteinyl-glycine linkage immune from attack by peptidases (cf. Binkley and Nakamura[23]). This type of effect may well be of some general importance in the intact cell, since it forms a mechanism whereby peptides may be protected from hydrolysis.

The postulated transpeptidation reactions leading to the interconversion of α-peptides by either carboxyl or amine transfer reactions (type *d* in the scheme) might prove to be closely connected with protein synthesis, since they would provide a mechanism for re-arrangement of amino-acid residues in α-peptide chain structures. Underlying this suggestion, we have had in mind from the beginning the possibility that the different proteolytic enzymes, with their sharply defined specificity characteristics, may catalyse such transpeptidation reactions, in addition to the hydrolytic reactions by which they are normally recognized. This would be in accord with the important discovery of Axelrod[28] that phosphatases will catalyse both group transfer as well as hydrolytic reactions. The suggestion that the proteolytic enzymes may catalyse transpeptidations, adumbrated by Lipmann[85] gains support from the recent work of Frantz and Loftfield[29] and especially of Brenner *et al.*[7], who have reported the synthesis of peptides by the action of chymotrypsin upon various esters of amino-acids, this being the result presumably of a carboxyl transfer from ester linkage with alcohol to peptide linkage with amino-acid.

Note added in proof. Since the above was submitted for publication, we have read the recent article (*Yale J. Biol. and Medicine*, p. 263, 1950), by J. S. Fruton, entitled "The Role of Proteolytic Enzymes in the Biosynthesis of Peptide Bonds". Fruton develops speculations regarding the possible significance of transpeptidation reactions which are parallel in many ways to ours. In support of the view that proteolytic enzymes may catalyse transpeptidation as well as hydrolytic reactions, Fruton gives evidence that a small but significant amount of isotopic ammonia is incorporated into benzoylglycinamide or carbobenzoxy-L-methioninamide under the action of papain. It seems appropriate here to mention that by another technique we have recently obtained more direct evidence of the existence of transpeptidation reactions involving α-peptides which are catalysed by plant enzymes.

Acknowledgments

We are grateful to Dr. E. Friedmann for valuable advice in the use of N-ethyl-maleimide and for supplying this compound. Our thanks are also due to Dr. F. Sanger for advice and assistance in the end-group determination.

One of us (F. J. R. H.) held a Sir John and Lady Higgins Research Scholarship (awarded by the University of Melbourne) when this work was begun. It has been continued under a research grant from the Agricultural Research Council. Support from these two sources is gratefully acknowledged.

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AGRICULTURAL GENETICS

CONFERENCE AT RIETI

A MEETING on agricultural genetics held at Rieti during May 30–June 3, although originally announced as a meeting of the Italian Society of Genetics and Eugenics, proved to be a truly international gathering, with representatives from Sweden, France, Switzerland, Spain, Portugal, Yugoslavia, Great Britain, the United States and Israel, and about two hundred Italian delegates. The opening ceremony was attended by the Under-Secretary for Industry and Commerce and many distinguished national, provincial and municipal officials. The meeting was organised by Prof. Carlo Jucci, of the University of Pavia, who was very largely responsible, by his enthusiasm, energy and wide scientific competence, for its success. The opening address was given by Dr. P. S. Hudson (Commonwealth Bureau of Plant Breeding and Genetics, Cambridge), who represented the headquarters of the Food and Agriculture Organisation, and speaking in Italian on "Genetics and Agriculture in International Organization", described the Organisation's World Catalogue of Genetic Stocks. This is a first attempt on a world scale to organise the collection and maintenance of information and living material of agricultural crop plants of potential value to plant breeders.

The second contribution was a paper by Dr. Å. Gustafsson (Sweden), on "Induced Mutations and the Viability Problem". Here some interesting data were given concerning certain mutants obtained by X-ray irradiation of barley. Many of these were of good viability, and some were fully fertile, so that irradiation clearly has potentialities as a tool in plant-breeding. Carefully controlled comparisons over several seasons gave indications that some of these mutations yield best in the years when the mother variety (in this case Maya barley) does not do so well. Dr. Gustafsson pointed out that this is in contrast with colchicine-induced polyploids, the seasonal yields of which follow those of their mother strains. Some mutant lines gave their highest yields with medium dressings of nitrogen, and were depressed by higher dressings which increased the yields of the mother strains. These and other data seemed to provide excellent demonstrations of the generalization that particular alleles each have their specific physiological optima. Irradiation has given rise to one very early line in barley, and to a line which has straw stiffer than that of any other known variety, and which is now already cultivated to a limited extent in Sweden. A line of white mustard with 4 per cent. higher yield and higher mustard content has been selected from irradiated material; but in view of the cross-pollination of this crop some uncertainty is felt as to whether this line has originated as a result of the irradiation. Interesting agronomic comparisons of chlorophyll-deficient mutants in barley were also given. Homozygotes of these are lethal, and in one case the heterozygotes, which gave lower yields than the normal in pure stand, gave higher yields under certain special conditions involving competition with normals in segregating progenies, and this superiority was greatest where competition was most intense. It was also shown that certain spontaneous chlorophyll-deficient lethals in barley, the single heterozygotes of which are in certain characters similar to the normals, are superior in dihybrid combinations, and the interesting view was expressed that such deleterious mutations may have taken a positive role in evolution.

A somewhat similar point of view was expressed by Dr. A. Câmara (Portugal), in an address on "Possible Contributions to Plant Improvement", in which an outline was given of the plant-breeding work in progress in Portugal and the methods employed. These include the artificial induction of mutations and polyploids, and the study of the caryological interrelationships of the species in wheat and other plants and the significance of polysomics.

The second day was devoted to discussion of the improvement of cereals, particularly wheat. Dr. Å. Åkerman (Sweden) outlined the history, organisation and achievements of the Swedish Seed Association at Svalöv. It is estimated that plant breeding and improved agricultural methods together have led to an increase of almost 50 per cent in the yield of wheat in Sweden, and increases of slightly more modest order in other crops. Attention was early devoted to investigation of the potentialities of special techniques such as the artificial induction of mutations and polyploidy. The latter technique appears to be most successful in crops which are grown for their vegetative parts, since fertility is usually depressed. Useful polyploid strains of alsike, red clover and winter rye are already available, and barley, rye, wheat, timothy, mustard, turnip, mangolds and sugar beet show promise. The importance was stressed, in all methods of breeding, of undertaking selection work on a sufficiently intensive scale, and of adequate facilities for field tests over a wide range of conditions. In connexion with the urgent problem of breeding a more winter-hardy wheat, resistance to winter damage by *Fusarium*, *Typhula* and other pathogens is of importance; laboratory methods of testing cold-tolerance were described, and the importance of preliminary hardening was stressed. Old land races are strongly winter-hardy but deficient in all other respects. Yield of winter wheat has been increased 70 per cent during the past fifty to sixty years, and half this increment is due to breeding. Baking-quality was not at first adequate, but, as Sweden became self-supporting in wheat, interest was taken in this feature, and Sweden can now obtain fully satisfactory baking flour by the blending of domestic winter and spring wheats. The contribution of the plant breeders to yield-increase in the spring wheats is estimated at a little more than 20 per cent.

In oats, of which only spring varieties are grown in Sweden, the important observation has been made that yield is not necessarily closely correlated with maturity class. Yield increments of 10–20 per cent are attributed to the breeder.

A short reference was made to oil plants. Cultivation of these was resumed in 1940 as a contribution to the supply of fats in the national diet. They now occupy an important place in the economy of the country, and their cultivation is being maintained, 170,000 hectares having been grown last year. The important oil crops are rape, white mustard and linseed. In addition to straightforward selection for winter hardiness, work is proceeding with polyploids and with interspecific crosses, the latter especially in the genus *Brassica*. Tetraploid types of all species groups of this genus have been obtained; but their vigour is in no case greater than that of their parent types, and often lower. The high-chromosome number species have been artificially synthesized, and these now offer a possibility of introducing winter-hardiness into rape. Progress has been made in improving the fertility of synthetic species through selection. Finally, Dr. Åkerman gave a brief description of provisions for testing, multiplying and distributing improved seed.

Dr. O. Gasparini discussed problems in connexion with seed production in Italy, and Dr. V. Boceta described some interesting results obtained in Spain with maize hybrids produced by crossing plants selected from consanguineous lines, a method which produces notable improvements in less time than that required for the selection of inbreds.

Dr. A. Dionigi described the work of the Nazareno Strampelli Cereal Research Station at Rieti, and the new direction it has taken since the death of the famous breeder, N. Strampelli, former director of the Station. The method now employed consists of making large numbers of crosses (two thousand or so have been made this year) and subjecting the hybrid material to preliminary testing under artificial conditions of environment—for example, in cold chambers at 4° C. for varying periods—before testing them in the field. It was explained that varieties even with the same maturity-period differ in the length of their various developmental phases, and that the treatment permits analysis of these phases and hence facilitates the selection of lines adapted to particular environmental conditions (elevation, cold, humidity, rust prevalence, etc.). It is claimed that, by subjecting segregating progenies to cold-chamber treatment, types can be selected which have developmental phases which are known, from experience and from comparison with standard varieties, to be suitable for particular conditions.

Dr. G. W. Adriance (United States) spoke on "Fruit Breeding Problems in Texas", mentioning especially the production of peaches with a low degree of cold-requirement and capable of giving fruit in Texas, where the winters are often so mild that the common peach varieties cannot be grown. Mild-winter tolerance was derived from the Chinese honey peach, which is not of the best quality and was therefore crossed with commercial types. Mention was also made of work with raspberries, figs and grapefruit. In connexion with the latter, he directed attention to the use of nucellar seedlings to screen out virus diseases, and as a means of rejuvenation of the variety.

Dr. Chanan Oppenheimer (Israel) spoke on fruit-breeding problems in Israel. He referred to the difficulty of growing apples, which suffer damage to blossom through lack of shade during the very hot days of early spring at a time when the trees are still leafless. Pollen-sterility and differences in time of flowering make hybridization with a small-fruited, locally adapted type difficult, but crosses with European types have been obtained, and these in later generations show transgressive segregation for time of leafing. Dr. Gustafsson recommended X-radiation of European types in an attempt to induce bud-mutations which might well be expected to include precocious leafing types.

Dr. A. Morettini presented a useful outline of the fruit-breeding work that has been done in Italy. Special mention was made of the achievements of Pirovano, who as the result of a half-century's labour has produced many excellent varieties of table grapes, some of them possessing special characters, such as a rose flavour or seedlessness, and others possessing new combinations of desirable characters such as high yield, earliness and large fruits. Valuable varieties of pears and peaches produced by Pirovano were also mentioned. Dr. Morettini then described his own work at Florence in producing improved varieties of peach, plum, pear and apple. Attention has now been turned also to the Japanese persimmon. Among the activities of other workers, special mention was made of the discovery at Acireale in Sicily of lemon varieties resistant to the die-back disease (*mal secco*). He stated that the genetic aspects of fruit-breeding have received little attention in Italy and that much requires to be done, especially on such characters as keeping-quality and transportability in relation to export requirements. He made a special plea for further support of such work, including the establishment of a fruit genetics research institute.

Dr. M. Marinucci discussed the problems of olive-breeding in Italy, pointing out the need for a fundamental attack from the genetic angle even though this should take centuries to complete. The existing varieties, of which there are many, all have some defect or other, and improvement in such features as drought- and cold-resistance would lead to great increases in production. Examination of further material from the centre of origin was strongly recommended. Studies on floral biology are important in the search for self-compatible varieties. Particular mention was made of work being carried out under Dr. Marinucci's direction at Perugia, where studies of respiration and glycolysis in different combinations of stock and scion have shown which combinations are the most favourable. Differences have been observed even between reciprocal combinations, expressing the different capacities of the respective varieties to utilize raw materials. In the discussion, Dr. R. Ciferri gave his views on the evolution of the cultivated olive, which seems to have been by a process of introgressive evolution, the hybrid evolved by a process of continued backcrossing with one parent, while the other parent of the original cross has disappeared. To what extent modern concepts of species variability had been taken into account in formulating this hypothesis was not clear.

Dr. G. Dalmasso outlined the history of vine-breeding from the pre-phylloxera period to the present day. Interesting points that emerged were that whereas French and German breeders had been almost completely preoccupied with attempts to achieve the hitherto unattainable goal of the direct-producer hybrid, in Italy the two Pirovanos, father and son, had gone ahead with improving the quality of the available material within the European grape species, and so attained the excellent series of varieties now available for grafting on to resistant stocks. Similar activities were carried on at the Viticulture Station at Conegliano under the direction of Dr. Dalmasso himself. He now considers, however, that it may well be profitable at this stage to re-examine the German method of approach, experience having shown that certain resistance genes do exist in the European vines, and by using large numbers of hybrids in advanced generations it is possible that the ideal direct-producer may yet be achieved. He further pointed out that, with the present knowledge of the laws of plant distribution, it is still possible that further collecting expeditions in America might reveal the existence of species capable of giving resistant hybrids of high quality.

The fourth day was devoted to grassland problems. The first contribution was by Dr. F. Marschall (Switzerland) on "Plant-Sociological Considerations regarding Alpine Pastures", in which it was shown that alpine plant species exist in many different and quite definite races, and that the classification of the associations is much more complex than has been supposed. A thorough study of these associations from the plant sociological point of view will undoubtedly help in selecting genetically suitable forms.

Dr. T. J. Jenkin, speaking on "Genetic Problems in the Breeding of Forage Grasses", described the work of the Welsh Plant Breeding Station in evolving strains of pasture grasses of greatly improved persistency and quality. By blending appropriate basic strains carefully selected for known characteristics, mixtures suitable for almost all sets of growing conditions in the British Isles can be obtained. Attention is being devoted to the production of special types for silage and grass-drying.

Interesting views were expressed concerning the evolution of the British strains of *Lolium perenne* from the annual *L. rigidum* of the Mediterranean. Though it has changed in very many genes and gene complexes, it is still not so completely adapted as to survive out of cultivation. On the other hand, *Festuca*, which has evolved by polyploidy, has produced species capable of surviving under ecological conditions other than those to which the parental species are adapted. This should be borne in mind in judging artificial polyploids, which may be inferior in the parental area but yet prove superior in an area outside the range of the parents.

Dr. G. Haussman (Lodi), in a paper on "Problems of Forage Plant Selection in Relation to the Fertility Potentialities of the Soil", laid special stress on the capacity of different plants to influence the soil structure, owing largely to differences in the type of root system they produce. Selection for the types most effective in this respect will contribute materially towards improving the quality of the swards and raising the production capacity of the land.

Dr. M. Mendizábal (Spain) described the work of the agricultural experiment station for arid zones at Almeria, the main problems of which are to find plants capable of growing under conditions where the mean annual rainfall is only 200 mm.

Dr. F. d'Amato (Pisa) gave an account of experiments in which 'Gammexane' was shown to have certain advantages over colchicine as a polyploidizing agent, especially in its low toxicity; it is effective over a very wide range of material. Dr. T. Castelli (Perugia), after giving a review of Winge's work on the genetics of the yeast fungi, reported some observations of his own in which a close correlation between spore form and fermentation capacities was demonstrated.

The final session on the fifth day was held at the Pontifical Academy of Sciences in the Vatican City. Dr. R. Esteruelas (Spain) reported on the work of the Aula Dei Agricultural Experiment Station near Zaragoza, where the activities, all directed towards improving the local crops, are divided into plant-breeding, cytology, ecology, phytopathology and physiology.

Dr. R. Téllez (Spain) referred to difficulties in applying the present systems of classification of wheat species and varieties to a large collection of agricultural varieties, and proposed that a meeting of interested parties should be organised at the next International Genetics Congress in Rome. The meeting unanimously agreed with this proposal.

One of the evening sessions was devoted to a visit to the projected Apennine Research Centre, to be operated jointly by the University of Pavia and the National Research Council. This Centre is a development of the work of Prof. Carlo Jucci in this locality during the past fifteen summers. It is situated in isolated country and with a magnificent outlook at an elevation of 1,730 metres on Monte Terminillo, a few miles from Rieti. The laboratories, in a converted barracks, are nearing completion, and are intended for general biological studies in the fields of taxonomy, cytology, histology, phytopathology and physiology. Particular emphasis will be given to studies in botanical evolution and adaptation on much the same lines as those followed by Jens Clausen and his co-workers at Palo Alto in California. Prof. Jucci hopes also that this will become an international study centre.

OBITUARIES

Dr. Fabius Gross

THERE was something unusually attractive about Dr. Gross; it was partly his self-confidence, bred of knowledge and hard experience, but more his charm of manner, his friendliness and his unfailing good humour in every situation, and not least the catholicity of his sympathies, in the arts as well as in the sciences. He was born in Krosno in 1906, when that town was still in Austria, and at the University of Vienna he studied biology under a distinguished group of teachers, Profs. Storch, Versluys, Przibram, Joseph and Wettstein. As a student he showed aptness for research, recognized by his association with Storch in investigations of the feeding mechanism of Crustacea and the biology of dragon-flies, and his own D.Phil. thesis (1929) was an analysis of the swimming movements of Cladocera based upon microscopic studies with cinéfilm. Three further years of research, on *Artemia* and *Noctiluca*, were spent with Prof. Hartmann at the Kaiser-Wilhelm Institut in Berlin, and then the rising tide of anti-Semitism drove him from his own land to seek shelter in Britain.

There, with the aid of the Academic Assistance Council, he was able to continue his studies—with Huxley at King's College, London, on regeneration in *Sabella* and mitosis in *Artemia*, with Fisher at University College on *Artemia*, and with Allen at Plymouth, where he commenced a promising line of investigation on culture methods for marine Protozoa which led to a study of the neglected micro-plankton and to a recognition of their importance as a basic food-supply for the larvæ of fishes and other marine animals. In 1937 he was appointed lecturer in experimental zoology in the University of Edinburgh, and for twelve years he shared in the work of the Zoology Department. Without previous experience of teaching he became a most stimulating teacher, careful in preparation, constantly devising and testing new experiments with his classes, and guiding his students towards reliance on their own observations rather than on the dogma of text-books.

Meanwhile, Gross continued his own researches, and the originality of his work was acknowledged by the first award of the Jacobsson Fellowship of Sweden, which enabled him during the summer term of 1939 to assist Prof. Hans Pettersson in inaugurating the use of the unique plankton-well in the new Oceanographic Institute of Göteborg. His work on this new venture, then and during a second visit in 1947, was greatly appreciated and admired by his co-workers in Sweden.

In 1940, with more recent refugees, he was interned under the Enemy Aliens Act; but he returned without rancour, and set about planning a series of experiments to test the effects upon the growth of fishes of adding ordinary chemical fertilizers to enclosed or partly enclosed arms of the sea. These experiments, financed by Imperial Chemical Industries, Ltd., were carried out by teams of scientific workers from the Edinburgh Zoology Department and Millport Marine Station, and the final reports on this, an important exploratory contribution to a new outlook on fishery research, appeared only a few days after Dr. Gross's death. He spent the summer vacation of 1949 at Woods Hole Oceanographic Institution, and had not long left Edinburgh to take up the important post of director of the Marine Biological Station to be created at Bangor for the University of Wales, for which he was eminently fitted, when symptoms of serious illness showed themselves; after a characteristically brave struggle he died in Edinburgh on June 18 and was buried there with Jewish rites on the following day.

JAMES RITCHIE

Dr. J. R. Ashworth

SCIENTIFIC societies in the north-west of Britain sustained a great loss on July 9 through the death of Dr. James Reginald Ashworth, of Rochdale. He had only recently resigned from the office of honorary secretary of the Rochdale Literary and Scientific Society, after sixty-five years, and he had been a co-opted member of the Public Libraries, Art Gallery and Museum Committee of Rochdale for sixty-three years. At the age of eighty-nine he had been an influence in Rochdale's cultural life long before many of those who now have to sustain it were born.

In 1893, two years after the Rochdale Technical School was built, Dr. Ashworth was appointed teacher of evening classes in magnetism and electricity and also in heat, light and sound under the old South Kensington scheme for science and art classes. At that time the teaching of physics was not general, except in colleges and universities; much work was therefore necessary in devising experimental courses, which were embodied in two practical text-books written by Dr. Ashworth. In the first year of his appointment, only twenty-three students attended the physics and electrical engineering courses, but when he retired in 1928, the number had risen to three hundred.

In the wider scientific world Dr. Ashworth built up a considerable reputation. He wrote eighteen books and pamphlets dealing mainly with various aspects of magnetism. Recognition of his authority on this subject was made in May 1939, when he was invited to address a conference on magnetism organised at Strasbourg by the French Central Council of Scientific Research.

Dr. Ashworth had also devoted much attention to the study of ultra-violet rays and their relation to sunspot frequency, and only a few months ago he published a small book on this subject, through the Liverpool University Press, based on his own daily observations over a period of sixteen years. He made a number of contributions to *Nature*, mainly on magnetism and also on atmospheric pollution and its effect on the transmission of ultra-violet radiation. For many years he had been deeply interested in the subject of atmospheric pollution. He installed a gauge on the roof of the Rochdale Technical School and made daily observations to the Smoke Abatement Society. He was a fellow of both the Royal Meteorological Society and of the Physical Society.

At the time of his death Dr. Ashworth was curator of the Manchester Literary and Philosophical Society. Up to the end of last year he was in good health, attending the Council meetings regularly and giving valuable advice. He recently presented the Society with a portrait of Joule, whose connexion with the old building in George Street, Manchester, is well known.

The Vicar of Rochdale (the Rev. G. E. N. Molesworth) pays the following tribute to Dr. Ashworth: "He said he valued above all things integrity and truthfulness of heart and mind. So indeed his life has proved. We shall not see his like again and we shall be immeasurably the poorer for it. He has reached the end honourably and unfalteringly with his finger on the pulse of passing events."

Dr. Ashworth was unmarried. He is survived by his elder brother, the Rev. G. H. Ashworth, of Cleadon, Sunderland, and his sister, Miss M. L. Ashworth, of Hindhead, Surrey.

Mr. Thomas Lewis

MR. THOMAS LEWIS, head of the Department of Applied Mathematics in the University College of Wales, Aberystwyth, died suddenly on July 6, at the early age of fifty-two. He had not been in good health for some time, but had appeared to be improving. His passing was a great shock to his colleagues at Aberystwyth, who had enjoyed his society only the day before.

Lewis was born at Newport, Pem., and attended the Cardigan County School. After service in the First World War, he entered the University College of Wales, Aberystwyth, in 1919, where he gained first-class honours in applied mathematics, and various University prizes and scholarships. He studied mathematics abroad at Cologne, Bonn and Zurich, coming under the influence of Weyl, and returned to Aberystwyth in 1925 to become assistant lecturer in, and in 1933 head of, the Department of Applied Mathematics. I first met Lewis when giving a course of lectures at Aberystwyth in 1933 on "World-Structure". He took a great interest in the subject of kinematic relativity, and in 1935 published (in the *Phil. Mag.*) a paper in which he suggested that the then unknown form of the acceleration function $G(\xi)$ in the equation of motion of a free particle in the presence of the substratum was probably $G(\xi) \equiv -1$; and he integrated the equations of motion on that hypothesis. Ever since then, he maintained an intermittent correspondence with me on these problems; and only in April last he sent me some notes on the dynamics of the photon and the secular variation of Planck's 'constant' h, which were of considerable interest though incomplete. Lewis also wrote on more conventional electro-dynamics, in particular on Dirac's theory of the world-line of an electron. He was also interested in fluid motion. In all his publications he showed great independence of outlook and fertility of invention. He was also interested in the philosophical implications of modern science, and wrote thereon in Welsh publications.

He is survived by his wife, three sons and two daughters. He will be greatly missed by the Bethel Welsh Baptist Church, and other circles of Welsh culture.

E. A. MILNE

NEWS and VIEWS

National Research Council (Canada): Dr. E. W. R. Steacie, O.B.E., F.R.S.

DR. E. W. R. STEACIE, director of the Division of Chemistry of the National Research Council of Canada, has been appointed vice-president (scientific) of the Council. In this new post, Dr. Steacie will be responsible for all scientific activities in the Council to ensure that the work of the several divisions proceeds according to a general plan and to maintain the closest integration of research throughout the laboratories. Dr. Steacie will continue as director of the Division of Chemistry, an appointment which he has held since 1939. During the Second World War he was deputy director of the British–Canadian Atomic Energy Project. He is forty-nine years of age.

Philosophy at Birmingham: Prof. A. B. Gibson

PROF. A. BOYCE GIBSON, of the University of Melbourne, has been appointed to the chair of philosophy in the University of Birmingham. He is already well known in Birmingham, having been a member of the philosophy staff from 1927 until 1935, and his many friends will welcome his return. The son of Prof. W. R. Boyce Gibson, whom he succeeded in the chair in Melbourne, he was educated in the University of Melbourne and in Balliol College, Oxford. He was temporary assistant in philosophy in the University of Glasgow during 1923–25, and staff tutor to the Joint Tutorial Classes Committee of Oxford in North Staffordshire during 1925–27, where he threw himself wholeheartedly into the movement for adult education. His book on the "Philosophy of Descartes" was published in 1932. Other publications include "Should Philosophers be Kings ?" (1939) and (with A. A. Phillips), "Thinkers at Work" (1946). A 'Greats' man and an idealist, he has a deep admiration for Plato. His special interests include political theory, æsthetics and philosophy of religion. The honorary degree of D.Litt. was conferred on him by the University of Cambridge in 1948, when he was in Great Britain as a delegate to the Conference of the Universities of the Empire.

Soil Survey of Great Britain

SOIL surveys were started in Great Britain nearly forty years ago; but not until after the First World War, when their use to the agricultural advisory services was realized, were any definite plans made for their development, or soil mapping put on a systematic basis. Since then, standard methods have been gradually built up, activities have been co-ordinated, and in 1939 the Soil Survey of England and Wales attained formal recognition. The general scientific supervision of the work is carried out by the Soil Survey Research Board, which has now issued its first report under the ægis of the Agricultural Research Council (pp. 27; London: H.M. Stationery Office, 1950; 1*s*. 6*d*.). This publication includes some account of the methods used and details of the areas surveyed during 1946 in England and Wales, and Scotland. Mapping is normally made on the scale of 6 inches to the mile; but a considerable amount of reconnaissance work has been done on the 2½- or 1-inch scale. The soils are classified into series, that is, those showing the same general profile characters and developed from the same or similar parent materials. So far, surveys have been almost entirely confined to agricultural soils, as the work is closely linked with the advisory service; but the general value of the work is evident, for, besides being of interest in itself, a knowledge of soils is also important for forestry and in all matters pertaining to land use.

Marihuana in Latin America

DR. PABLO OSVALDO WOLFF, a member of the Expert Committee of the World Health Organisation on Habit-forming Drugs, has written a valuable pamphlet entitled "Marihuana in Latin America, the

Threat it Constitutes" (pp. 56; Washington 6, D.C.: Linacre Press, Inc., 1949; 1.50 dollars), and nobody who reads it can remain in doubt of the evil effects of this drug, which is popularly known under the name of hashish, or Indian hemp. Hemp, says Dr. Wolff, has innumerable common names in various countries, and he relates that the hashish of the Middle East, the kif of North Africa (kif being Arabic for tranquillity or peace), the dagga of South Africa, the anascha of the U.S.S.R., the esrar of Turkey and Persia, the marihuana of Spanish-speaking America and the United States, and the maconha of Brazil are all names for the same substance, which has other names as well. Dr. Wolff discusses its uses, general effects, the value of experimental observations made with it, its psychopathic manifestations and relationship to crime and delinquency, the medico-legal problems that it creates and the use of it in the Latin American countries. After reading his pamphlet, it is indeed difficult not to agree with him that, while opium "cures and punishes like a god", there is no reason or excuse for the use of marihuana, which "has been closely associated since the most remote time with insanity, with crime, with violence, and with brutality". A bibliography of eighty-three references adds to the value of this pamphlet, which presents its facts so vividly and yet in language which everyone can understand.

East African Industrial Research Board

The seventh annual report of the East African Industrial Research Board (Nairobi: 1*s.* 6*d.*), now operating under the East African High Commission, covers the year ended December 31, 1949, and records that investigations have largely been concentrated on projects already receiving attention. In the field of ceramics, much effort was given to the development of a clay glazing technique for domestic pottery which might lend itself to the production of decorated ware for markets overseas, and steps were taken towards the establishment of the export of high-grade refractory products. Work on bricks and roofing tiles continued, and a suggestion for bonding a natural diatomite, unfired block with sisal fibre for the production of insulating slabs has been adopted commercially. Besides supplying fertilizer by calcining rock phosphate and soda ash for field trials throughout East Africa, laboratory work on the composition of the product continued, as well as the study of the making of bricks from this mixture. Laboratory work on the extraction of pyrethrins from fresh flowers was completed, and some work carried out on the storage of fresh flowers and the so-called 'fermentation' of closely packed flowers, the analysis of undried flowers and the loss in dry material in drying pyrethrum flowers.

National Foundation for Scientific Research, Belgium

The twenty-second annual report of the Belgian National Foundation for Scientific Research covers the year 1948–49 (pp. 185; Brussels: Fonds National de la Recherche scientifique, 1949). The scientific activities of the Inter-University Institute for Nuclear Physics have included photographic plate technique and cosmic ray studies, the separation of isotopes by thermodiffusion in the liquid phase, the preparation of uranium oxide, the metallurgy of uranium, preparation of pure graphite, geological applications of radioactivity, technique of thin photographic emulsions, preparation of fluorine and uranium hexafluoride, mass spectrography, nuclear isomerism, investigations on the secondary ionization caused by a stream of slow neutrons, and arrangements for obtaining very high temperatures. A report is included on the distribution of radioisotopes in Belgium and also on work during 1948–49 at the Jungfraujoch Scientific Station, under Prof. M. Morand. This has dealt with cosmic rays and the nuclear reactions they produce in photographic plates and has included the study of the essential properties of neutrons and protons of energy greater than that which can be attained with the most powerful cyclotrons or other generators. In addition to details of the membership of the various scientific committees, the report includes an analysis of the distribution of research grants made since the establishment of the Foundation and a list of the national research centres. Lists of recipients of grants, totalling 3,250,000 francs, during the year 1949–50 and including the research objectives are appended, together with a list, by recipients, of publications during 1948–49.

National Central Library, London: Annual Report

The thirty-third annual report of the executive committee of the National Central Library (pp. 32; London: National Central Library, 1950) covers the year ended February 28, 1949, and records a smaller total increase of 10·43 per cent in the issues of books from or through the Library to all categories of libraries which it serves. Total issues were 93,745 as against 84,889 in 1947–48, and, of these, 10,445 were to or from university libraries, 695 to or from Imperial or foreign libraries, and 9,405 to or from the libraries of government departments, research and industrial organisations, etc. Issues from the Scottish Central Library for Students were 15,717, as against 15,547 in 1947–48, and from the Irish Central Library for Students, 12,873 as against 13,082, while total issues of the adult class department, the stock of which was augmented by 3,584 volumes, increased from 12,652 in 1947–48 to 18,123. Reference is again made to the value of the Bureau of American Bibliography as a source of information about American books and periodicals, and to the increased assistance given by the outlier libraries, which lent 17,926 volumes during the year compared with 15,023 in the previous year. Work has progressed steadily on the union catalogue of books in the Russian languages in libraries in the United Kingdom, and compilation of a union catalogue of all German war-time periodicals held by British libraries has been commenced. There are arrears of approximately 443,000 entries still to be incorporated in the National Union Catalogue, but work has proceeded on the Union Catalogue of outlier libraries, and entries contributed to Union Catalogues total 3,639,963 at the National Central Library, 885,181 in Wales, and 140,278 in Scotland. During the earlier part of the year, the British National Book Centre was still engaged largely in disposing of the remaining stocks of books and periodicals transferred in December 1946 from the Inter-Allied Book Centre, but later the staff proceeded to make systematic arrangements for its main task of co-ordinating the exchange of redundant material within Great Britain and between Britain and other countries. The Treasury grant-in-aid was increased from £14,500 to £19,000, including a sum of £1,000 to compensate for the first stage in the discontinuance of the contribution from the Carnegie United Kingdom Trust.

Australian Journal of Marine and Freshwater Research

A NEW scientific periodical, the *Australian Journal of Marine and Freshwater Research*, has been established by the Commonwealth Scientific and Industrial Research Organisation as a medium for the publication of research papers on the results of original investigations on sea, estuarine and freshwater fisheries and cognate subjects. Dr. N. S. Noble, of the Organisation's staff, has been appointed as editor of the new *Journal*. He will have the help of an Editorial Advisory Committee including Mr. G. Humphrey (Department of Biochemistry, University of Sydney), Prof. P. D. F. Murray (Department of Zoology, University of Sydney) and Dr. H. Thompson (Chief, C.S.I.R.O. Division of Fisheries). The *Journal* will not be issued at set periods, but as the accumulation of suitable material dictates. It is possible, however, that two issues will appear each year. The subscription rate is A.7*s*. 6*d*. per issue. Further information can be obtained from the Secretary, C.S.I.R.O., 314 Albert Street, East Melbourne, C.2, Australia.

Documentation of Architecture and the Building Industry in Italy

A NEW quarterly, *Documenti di Architettura e Industria Edilizia* (Centro Studi Abitazione presso il Consiglio Nazionale Ricerche, Piazzale delle Scienze, 7 Rome; home, 1,800 lire; foreign, 3,600 lire a year), is, for the most part, a production inspired and guided by the Building Documentation Conference held in Geneva in October 1949. Part 1 consists of abstracts from the Italian literature, in boxes, eight to the page (each size *A*7), with the Universal Decimal Classification numbers on the top right corner. On one side the abstract is in Italian for domestic use, while on the back it is in French for international use; the abstracts may thus be cut out, attached to cards and filed by the Universal Decimal Classification. Parts 2–5 consist respectively of: selected foreign abstracts (in Italian for domestic use); data sheets (in Italian and French) of the form introduced in 1948 by the Bouwcentrum, Rotterdam, in which a building is described in detail with photographs, plans and elevations; reviews of foreign literature (in Italian); and an outline of standards relating to buildings in one or more foreign countries. By this publication there is made available to the building industry all over the world a complete analysis of the relevant Italian literature already abstracted and classified. As the first national publication of its kind, it is a model example for others to follow. Seventeen countries have agreed to publish similar abstracts, and the realization of the full international scheme will have a very great effect in promoting co-operation in building industry research, as well as pointing the way to the solution of similar problems in other industries.

President Truman's Fourth Point

THE Fourth Point in President Truman's inaugural address of January 20, 1949, called for a "bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of undeveloped areas". According to the March volume of the *Annals of the American Academy of Political and Social Science*, which contains a valuable symposium on "Aiding Undeveloped Areas Abroad", this Fourth Point is becoming one of the most discussed features of United States foreign policy of the present day. Briefly, the proposal is that the United States should make available its technical knowledge to those living in undeveloped areas, who then, by combining their own resources with 'know-how', may be enabled to improve the conditions under which they live. This is supplemented by the further proposal that capital investment in areas needing development should be fostered on a joint basis. Nineteen contributors have been enlisted by the editor of the *Annals*, each a leading authority on the topic, and the symposium covers the objectives of the programme, the international environment to which it applies, the existing means of putting the programme into effect, and some of the results which reasonably may be expected. A considerable measure of agreement has been achieved by the contributors, despite the diversity of their backgrounds and the so far largely unformulated character of the programme. Though not unaware of the obstacles in the way of application, they see in the programme an important feature of the United States foreign policy.

Effect of Musical Accompaniment to Educational Films

IT is important for teachers and educational film makers to know the conditions for obtaining the maximum attention for the visual element in films. An investigation made by Mr. C. Denis Pegge, of the Cambridge University Educational Film Council, provides evidence that musical accompaniment to 'silent' films aids attention. During the course of film sessions given in the regular teaching time-table of second-year engineering students, a film session was arranged to allow accompanied and unaccompanied 'silent' films to be compared. No indication was given beforehand that this film session would differ from the others, and during the showing normal procedure was so far as possible followed. Each film lasted about ten minutes. The music was of low volume, by Litolff and Raff. The first film was projected without, and the second with, accompaniment. The students who thought music had aided their attention were 52, those who thought it had hindered attention were 2, and those who thought it made no difference were 5. The third film was then projected with accompaniment and the fourth film without. Judging by all four films seen, the students who thought music aided attention were 42, those who thought it hindered attention were 5, and those who thought it made no difference were 13.

Indo-Pacific Fisheries Council: Second Annual Meeting

THE Indo-Pacific Fisheries Council held its second annual meeting at Cronulla, New South Wales, Australia, during April 17–28. The meeting was attended by thirty-five representatives of eleven of the fourteen member governments of the Council. Representatives were also present from the Supreme Command of the Allied Powers (in Japan), the United Nations Educational, Scientific and Cultural Organisation and the South Pacific Commission. The Council elected Dr. J. D. F. Hardenberg, of Indonesia, as its chairman, and Dr. D. V. Villadolid, of the Philippines, as vice-chairman for 1950–51. Technical committees were appointed, and various *ad hoc* subcommittees were set up. Technical Committee I, which deals with biology and hydrology, proposed to do work on the tunas and on the neritic–pelagic group of fish, and will carry out studies on fish culture, the transplantation of fish, planktology, hydrology and taxonomy; Mr. W. H. Schuster, of Indonesia, was appointed chairman, and Mr. G. W. Rayner, of Australia, *rapporteur*. Technical Committee II, which is concerned with technology, economics and statistics, will continue its programme of surveying the industries of the Indo-Pacific region; Mr. Claro Martin, of the Philippines, was appointed chairman, and Mr. C. G. Setter, of Australia, *rapporteur*. A number of technical papers covering a wide range of activities were received by the Council, and the Committee sent in reports submitting recommendations and resolutions for future work. One of the major projects of the Council consists of a register of the projects, institutions, vessels and personnel concerned with fisheries work in the Indo-Pacific region. Plans have been made for the completion of this register and for its publication at the earliest opportunity.

Guide to the Pharmacy of Poisons

ONLY a small proportion of scientific workers have to deal with poisons; but those who do will be glad to have the fifth edition of the "P.J. Poisons Guide" (pp. 46; London: Pharmaceutical Press, 1949; 3*s*. 6*d*., interleaved 4*s*.), which contains a great deal of valuable information. It summarizes the Pharmacy and Poisons Act, 1933, giving lists of substances included in its four schedules, and also the Pharmacy and Medicines Act, 1941. These summaries are followed by an extended list of poisons and substances containing poisons, with an indication of the special restrictions applying to each. The fifth, eleventh, twelfth, thirteenth and fourteenth schedules to the poisons rules are also reproduced.

Precautionary Measures against Toxic Chemicals used in Agriculture

THE Minister of Agriculture and Fisheries has appointed a working party on precautionary measures against toxic chemicals used in agriculture. Its terms of reference are: "To make recommendations for the promotion of the safety of workers in the agricultural use of substances which are toxic or harmful to human beings: and in particular to advise on the recommendations on this subject made in the Report of the Gowers Committee on Health, Safety and Welfare in non-industrial Employment". The membership of the working party is as follows: Prof. S. Zuckerman (*chairman*), Mr. A. B. Bartlett, Dr. R. A. E. Galley, Mr. C. T. Gimingham, Mr. A. Holness, Mr. W. Morley Davies, Mr. R. G. C. Nisbet, Dr. J. M. Rogan and Mr. H. Cole Tinsley. The joint secretaries are Mr. K. R. Allen, Office of the Lord President of the Council, and Dr. J. T. Martin, Ministry of Agriculture and Fisheries (Plant Pathology Laboratory).

University of London

THE following appointments have recently been made: Dr. Frederick Murgatroyd, to the Wellcome chair of clinical tropical medicine tenable at the London School of Hygiene and Tropical Medicine; Dr. S. D. Elek, to the University readership in bacteriology tenable at St. George's Hospital Medical School; Dr. Bernhard Katz, to the University readership in physiology tenable at University College; Dr. D. S. Rice, to the University readership in Islamic art and archæology tenable at the School of Oriental and African Studies. The title of reader in photo-elasticity in the University has been conferred on Mr. H. T. Jessop, in respect of the post held by him at University College, and that of reader in highway engineering in the University on Mr. B. G. G. Manton, in respect of the post held by him at the Imperial College of Science and Technology.

Announcements

BY an Order of the Committee of Privy Council for Medical Research, made after consultation with the Medical Research Council and with the president of the Royal Society, Prof. W. E. le Gros Clark, professor of anatomy in the University of Oxford, and Prof. F. G. Young, professor of biochemistry in the University of Cambridge, have been appointed to be members of the Medical Research Council from October 1, and by the same Order Group Captain C. A. B. Wilcock has been re-appointed a member from that date.

MR. R. L. FORTESCUE has been appointed senior lecturer in charge of the Particle Accelerator Laboratory, which is under construction at Queen Mary College, London, and which is designed for the study of machines used in nuclear physics and radiotherapy and the principles relating to the use of nuclear energy; since 1945, Mr. Fortescue has been working at the Atomic Energy Research Establishment, Harwell, as a principal scientific officer.

THE following officers of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., have been elected for the year 1950–51: *President*, M. H. Taylor; *Vice-Presidents*, J. E. C. Bailey and A. W. Smith; *Honorary Treasurer*, S. Borthwick; and *Honorary Secretary*, J. Rock Cooper.

THE Pharmaceutical Society's research scholarship of £300 a year for two years has been awarded to Miss B. P. Jackson, who since 1947 has been a member of the staff of the Department of Pharmacy, University College, Nottingham (now the University of Nottingham), and of the School of Pharmacy, University of London. Miss Jackson will work in the Museum of the Society on genetical and cultivation investigations of vegetable drugs.

A RESEARCH fellowship in electrical engineering, to be known as the W. T. Henley fellowship, has been established by Messrs. W. T. Henley's Telegraph Works Co., Ltd., at Queen Mary College, London. The fellowship, which is worth up to a maximum of £600 a year, is for senior research workers who have already had some works experience, and it is hoped that the investigations carried out will be more particularly in the field of dielectrics, high-voltage engineering and arc-interruption phenomena, for which the resources of the College are particularly good.

THE publication by the Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex, at the very low price of 2*s*. 6*d*., of its brochure on the equilibrium diagrams of the tin alloys will be welcomed by all metallographers. It is extremely well produced, the diagrams are adequately large and very clear, while the references will be still further welcomed. Although the diagrams published deal only with the binary alloys, there is a very useful bibliography of the ternary ones. Where the crystal structure of the phases has been worked out, the results are given, together with short notes on discrepancies between the results of different workers.

NATURE AND RELATIONSHIPS OF THE SPECIFIC PRODUCTS OF THE HUMAN BLOOD-GROUP AND SECRETOR GENES*

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THE classical blood-group characters shown by human erythrocytes arise from the presence of substances which are specific gene products, each of which, together with its specific immunological character, arises as if controlled by a single gene. Schiff and Sasaki[1] established many years ago that within the *ABO* classification the presence or absence of water-soluble specific group substances in the tissue fluids and secretions of an individual is controlled by a pair of allelic genes, *S* and *s*, *S* being dominant in effect to *s* and determining the secretion of the specific substance. It would, therefore, be correct to say that the presence of the water-soluble *A*-, *B*- and *H*-substances is controlled by the genes specific for these characters *and* by the gene of secretion, *S*. Those individuals who secrete their blood-group substances in a water-soluble form are termed 'secretors', whereas those who do not secrete these factors or do so weakly are called 'non-secretors'.

The isolation and characterization of these specific substances has been the subject of numerous investigations within the past few years, and it is now believed that the specific blood-group characters are due to well-defined chemical entities known as mucoids, or more precisely as polysaccharide – amino-acid complexes[2].

The soluble material secreted by group *O* persons —the so-called *O* substance mentioned so frequently in the literature—is not a specific product of Bernstein's *O* gene[3]. This substance is secreted by individuals belonging to all groups within the *ABO* system, not excluding group A_1B. According to Bernstein's theory, the latter genotype cannot possess an *O* gene. For reasons which have been described in detail elsewhere, this so-called *O*-substance is better called *H*-substance, to indicate its heterogenetic character and to show that it is a common secretion of the great majority of persons who are 'secretors', irrespective of their *ABO* group[4]. The erythrocytes and secretions of persons who possess anti-*H* agglutinins in their sera show no capacity to react with this iso-agglutinin.

A new human blood-group character called 'Lewis' was described a few years ago by Mourant[5], who found that the red blood cells of about 25 per cent of English people are agglutinated by anti-'Lewis' sera and that the agglutination is independent of the other known blood-group characters (*ABO*, *MN*, *Rh*, *P*, Lutheran and Kell systems). Andresen[6] in Denmark observed that anti-'Lewis' serum agglutinates the erythrocytes of about 75 per cent of Danish children who are less than six months old, and that parents, the red cells of both of whom fail to agglutinate with these sera, can have children whose erythrocytes are agglutinated. Andresen concluded that the agglutinability of the erythrocytes of adults behaves as a recessive Mendelian character, that is, adult persons whose red cells possess this agglutinability are genetically homozygous. More recently, Race[7] and his co-workers have found that the results of family studies for the 'Lewis' character strongly support this conclusion.

Two 'Lewis' genes are now recognized and are designated by the symbols Le^a and Le^b, and the corresponding antibodies to the gene products by anti-Le^a and anti-Le^b. If the antiserum, anti-Le^a, is used alone in agglutination tests, the phenotype of the cells which react is defined as $Le(a+)$, those not agglutinated, as $Le(a-)$. Though it has since been shown that the 'Lewis' and *ABO* genes are jointly responsible for certain serological phenotypic characters, the two systems are genetically independent.

It has been found that all persons whose red cells are agglutinated by anti-Le^a serum and who are presumably of the genotype Le^aLe^a are non-secretors of their corresponding *A*-, *B*- and *H*-substances[8]. The close correlation of the agglutinability of adult erythrocytes with anti-Le^a serum—the so-called 'Lewis' positive character—with non-secretion within the *ABO* system is of great interest, and when considered in the light of the finding that 'Lewis'-positive people secrete a water-soluble specific Le^a-substance in their tissue fluids, reveals the fact that the great majority of individuals secrete a blood-group factor and that there are probably no persons who are really 'non-secretors' in the sense of not secreting a blood-group substance. The converse relationship between adult cells which fail to agglutinate with anti-Le^a serum—'Lewis'-negative character —and the secretion of the *ABO* blood-group substances is also very close, but not absolute, and it has been found that possibly about one per cent of all individuals secrete neither *A*-, *B*-, *H*-, nor the 'Lewis' Le^a- and Le^b-substances. It seems probable that this small group of persons are, in fact, secreting a blood-group substance which might well be a product of a third 'Lewis' gene, Le^c. As the corresponding antibody is unknown and the genetics of the 'Lewis' system are not completely understood, it is not possible at the moment to know whether this suggestion is correct.

Here two points of some practical importance might be mentioned. First, a good estimate as to the secretor – non-secretor status of an individual within the *ABO* classification can be made on the basis of a simple agglutination test with anti-Le^a serum. Erythrocytes which show agglutination are derived from persons who are *ABO* non-secretors. The determination of non-secretion within the *ABO* system likewise indicates that the person concerned is most probably 'Lewis'-positive and possesses the Le^a gene in double dose. Less than one per cent of individuals are likely to prove exceptions to these conclusions. Secondly, it may be concluded that in the secretions of an individual, Le^b-substance and *H*-substance (and *A*- and/or *B*-substances if the person belongs to groups *A* and/or *B*) will be found *together*. The biochemical problem of isolating the Le^b-substance as a serologically homogeneous material is likely to be considerably more difficult than that encountered in obtaining Le^a-substance as an essentially homogeneous entity.

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* A contribution to a symposium on "Biochemical Genetics" arranged by the Genetical Society and held at University College, London, on March 29.

Table 1 Analytical Figures (average values) for Preparations of the Human Blood-group Substances

	Rotation	Nitrogen	Acetyl	Hexosamine*	Reduction†	Fucose**
	$[\alpha]$	%	%	%	%	%
A-Substance	+15°	5·7	9·0	37	56	13
H-Substance	−30°	5·3	8·6	31	54	13
Le^a-Substance	−40°	5·0	9·9	32	57	12

* As glucosamine base.
† In terms of glucose equivalent.
** Hydrolysis and periodate oxidation; estimated as acetaldehyde.

The examination of the physical, chemical and serological properties of the A-, H- and Le^a-substances shows how very similar they are, and some of the analytical figures obtained for these materials are given in Table 1. The group substances are judged to be essentially homogeneous on the basis of their physical, chemical and immunochemical behaviour. The sedimentation and diffusion constants of the A-substance indicate that the particle size of this material is not less than 250,000, and preliminary values of these constants for the H- and Le^a-substances suggest that these materials are of the same order in size. Examined in the Tiselius electrophoresis apparatus at pH 4 and 8, the materials migrate slowly towards the anode as a single, well-defined boundary. The inhibition end-points found when the substances are titrated against two to three completely agglutinating doses of homologous and heterologous human iso-agglutinins are set out in Table 2, and show that the amount of heterologous specificity in each material is quite small, certainly less than 1 per cent of the activity shown with the homologous reagent. Each of the A-, H- and Le^a-substances yield about 13 per cent of the methyl-pentose, L-fucose, on mild acid hydrolysis, and lose completely their specific group character. At the same time the substances develop or display enhanced reactivity with horse anti-pneumococcus type XIV serum and thus reveal the presence of a common structural unit. The group substances give qualitatively similar amino-acid (eleven amino-acids) and sugar chromatograms, and in each group material there is present, in different proportions, both glucosamine *and* chondrosamine[9]. Finally, the group materials after treatment with alkali under rather special conditions yield, on the addition of Ehrlich's reagent, a bright purple-red colour. This characteristic property, which is due to the extreme alkali lability of an unidentified structure common to all the group substances, has not been encountered during the examination of many other complex mucopolysaccharides and can, until it is found to be otherwise, be considered as a reasonably specific test for the blood-group mucoids or materials closely related to them. It is of interest to report that a further mucoid material, of unidentified blood-group character, has been isolated from the secretion of an individual known to belong to the rare 'Lewis' phenotype $Le(a-b-)$ non-secretor ABH, and this material likewise gives this characteristic and apparently specific colour reaction.

It has been observed that all persons who possess Schiff's secretor gene, S, have red cells which are not agglutinated by anti-Le^a serum, and it would appear, therefore, that there is a close, although inverse, relationship between Le^a and S genes. The great majority of the bloods which fail to react with Le^a serum, however, react with anti-Le^b serum. It is probable that adult bloods of the phenotype $Le(a+b+)$ do not exist; they have certainly not been observed. It might be anticipated, therefore, that there is some kind of close relationship between Le^b and S genes. A number of specimens of human H-substance were tested for their capacity to neutralize each of several specimens of human H and Le^b antibody and the two activities expressed as a ratio. The results suggest that human H-substance and Le^b-substance are not identical, and the detection of individuals of the phenotype $O\ Le(a-b-)$ secretor of H-substance but not of Le^a- or Le^b-substance gives further evidence for believing that genes S and Le^b are not identical.

Table 2. Serological Specificity of Human Blood Group Substances. End-Titre of Inhibition against 2–3 Agglutinating Doses of Human Serum

	Anti-A	Anti-H	Anti-Le^a
A-Substance	1×10^6	$<1 \times 10^2$	$<1 \times 10^4$
H-Substance	$<2 \times 10^2$	5×10^6	2×10^2
Le^a-Substance	$<2 \times 10^2$	$<2 \times 10^2$	1×10^6

Individuals whose red cells are agglutinated by anti-Le^a serum most probably possess, as stated earlier, the Le^a gene in double dose, and they are non-secretors of A-, B- and H-substances. Schiff and Sasaki showed that non-secretors within the classical ABO system possess the gene of non-secretion, s, in double dose. Does the very close correlation which clearly exists between the occurrence of $Le(a+)$ erythrocytes and non-secretion within the ABO system indicate that the genes Le^a and s are identical? A few individuals have been observed of the phenotype $Le(a-b-)$ in whose saliva no A-, B-, H-, Le^a- or Le_b-substances are detectable. The existence of such persons makes it improbable that genes Le^a and s are identical.

Is this very close correlation of 'Lewis' character and non-secretion an instance of linkage in man? It is obvious that if Le^a and s genes are linked, the linkage must be a very close one, as in the Rh system, otherwise crossing over would obliterate the observed $Le(a+)$ – non-secretor association in the general population.

It has already been suggested that a close linkage of this kind allows one to place these genes and the genes Le^b and S in one genetic system, and the fact that the physical and chemical properties of the soluble products of these genes, the Le^a-, Le^b- and H-substances, are very similar might lend some support for this action. As a tentative scheme, therefore, one might consider that there are two sets of allelomorphic genes S and s, and Le^a, Le^b and Le^c which occupy contiguous loci. The 'Lewis' genes Le^a, Le^b and Le^c are then considered as multiple allelomorphs. A somewhat more complex 'Lewis' system has already been proposed[10].

It has been stated that a series of genes which can occupy the same locus in the chromosome (multiple allelomorphs) have similar functions and produce similar gene products. This being so, it is not surprising that the products of the A and B genes are basically similar materials. If the so-called O-substance (H-substance) is not a product of a gene allelomorphic with genes A and B—and there are reasons for believing it is not—it is perhaps more surprising that this material is so similar chemically to the A- and B-gene products. Similarly, the genes Le^a and Le^b, which are responsible for the development of the 'Lewis' blood-group characters, are on different chromosomes from those which carry the A- and B-genes, or at least are so remote in position on the same chromosome as to give no evidence of linkage with A- and B-genes. In spite of this the Le^a and Le^b genes give rise to specific substances—the Le^a- and Le^b-substances—which are found to possess a type of molecule very similar to the A- and

B-gene products. These serologically different complex molecules, all of which seem to belong to a special type of polymolecular aggregate, are characteristic of the water-soluble blood-group substances, and it would appear that there is a common or basic molecular framework which develops minor quantitative, and perhaps qualitative or stereochemical, modification according to the specific action of the gene concerned with its production.

Since genetics is concerned with the innate differences between individuals, the results described above are of immediate interest. The urgent problem is to determine the precise differences in the closely related gene-products discussed. The results of an immunochemical approach along these lines will ultimately express in chemical terms an important aspect cf the specific action of the blood-group genes in man.

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SONIC DISINTEGRATION OF ISOLATED LIVER MITOCHONDRIA

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RECENT studies of the biochemical properties of intracellular components isolated from mammalian liver by means of centrifugal fractionation have indicated that the mitochondrion is responsible for a number of important enzymatic processes of the cell. Among the enzyme systems associated with isolated mitochondria are cytochrome oxidase[1,2], succinoxidase[1,2,3], adenosinetriphosphatase[1], octanoic acid oxidase[4,5], oxalacetic acid oxidase[6], and diphosphopyridine nucleotide – cytochrome reductase[7]. It may be noted that all these systems have, up to the present, been refractive to purification and detailed study because of their 'insolubility'. Of the better-characterized proteins which have been obtained from animal tissues in soluble form, only a few, for example, cytochrome c[8,9] and triphosphopyridine nucleotide – cytochrome reductase[10], have been found in mitochondria in a concentration exceeding that in whole liver.

Parallel studies relating to the structure of mitochondria, including cytological observations of the behaviour of the isolated particles when subjected to changes in the osmotic pressure of the suspending media[3], have provided evidence for the existence of a well-defined mitochondrial membrane. Although this evidence has been substantiated by electron microscopy[11,12], there remains some question as to the integrity of the membrane, as judged by its ability to retain soluble compounds after the mitochondrion has been released from the cell.

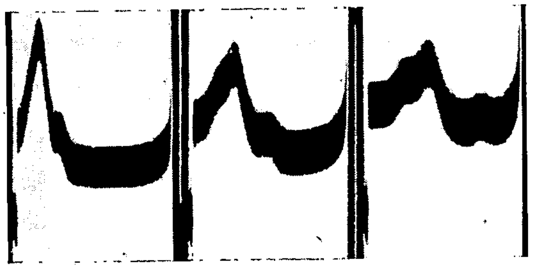
In view of these findings, it was considered of interest to determine whether the activity of several of the complex 'insoluble' enzyme systems is dependent on the structural integrity of mitochondria, and whether mechanical disruption of the mitochondrial membranes would result in the release of a significant amount of soluble material. Preliminary investigations that appear to have a bearing on these problems have been carried out.

Mitochondria were isolated from rat liver homogenates prepared in 0·25 *M* sucrose by a procedure described elsewhere[9]. The final preparation (*M*, cf. table), consisting of mitochondria that had been sedimented three times and resuspended in 0·25 *M* sucrose, was essentially free of nuclei, submicroscopic particulate material, and non-sedimentable nitrogen-containing compounds. The preparation was subjected to sonic vibrations in a 9-kc. per second oscillator (Type *R*-22-3, manufactured by the Raytheon Co., Waltham, Massachusetts) until phase-contrast microscopy revealed relatively few remaining visible particles. During this operation, which required 35–55 min., the temperature was maintained at 2–3° C. The resulting slightly opalescent suspension (M_S, cf. table) was centrifuged for 10 min. at 9,200 rev./min (5,000 g) using the multispeed attachment of the international refrigerated centrifuge. The small pellet of residual unbroken mitochondria was resuspended in 0·25 *M* sucrose (Sd_1, cf. table), and the supernatant fluid was centrifuged at 50,740 rev./min. (148,000g) for 30 min. at 3° C. in the Type *A* preparative rotor of the Model *E* Spinco ultracentrifuge (Specialized Instruments Corp., Belmont,

EFFECT OF SONIC VIBRATIONS ON ENZYMATIC ACTIVITIES OF ISOLATED LIVER MITOCHONDRIA

Preparation*	Total Nitrogen†	Cytochrome oxidase		Succinoxidase		Octanoic acid oxidase		DPN-cytochrome reductase	
	Recovery‡	Recovery‡	Qo_2§	Recovery‡	Qo_2§	Recovery‡	Qo_2§	Recovery‡	Q‖
M	(100)	(100)	9,800	(100)	2,160	(100)	353	(100)	3·50
M_s	98·0	83	8,530	50	1,090	0	0	88	3·20
Sd_1	6·2	7	8,600	5	1,660	0	0	4	1·76
Sd_2	39·0	36	10,400	36	2,200	0	0	46	4·75
S_s	57·7	25	4,350	5	186	0	0	31	1·41

* For explanation of symbols denoting preparations, see the text.
† The average total nitrogen content of the original suspensions of mitochondria (Preparation *M*) was 0·610 mgm. per ml.
‡ Per cent recovered from original preparation of mitochondria (Preparation *M*).
§ Microlitres oxygen consumed per hr. per mgm. nitrogen at 38° C.
‖ Micromoles cytochrome *c* reduced per min. per mgm. nitrogen at 24° C.



Sedimentation of mitochondrial proteins. Protein concentration approximately 2 per cent in 0·06 M potassium phosphate buffer, pH 7·4; centrifugal force at centre of cell, 260,000 times gravity; temperature 24° C.; photographs taken at 16-min. intervals; magnification, 1½ diameters

California). The clear yellow supernatant (S_2, cf. table) was removed, and the firmly packed, reddish-brown pellet was resuspended in 0·25 M sucrose (Sd_2, cf. table).

The effect of sonic vibrations on the cytochrome oxidase, succinoxidase, octanoic acid oxidase, and diphosphopyridine nucleotide – cytochrome reductase activity of rat liver mitochondria is shown in the accompanying table. Determination of the enzyme activities was carried out as described previously[1,4,7], and each value in the table represents the average obtained in two or more experiments. It is apparent that, although all the enzyme systems were affected to some extent, there was considerably greater inactivation of succinoxidase than of cytochrome oxidase or diphosphopyridine nucleotide – cytochrome reductase. Octanoic acid oxidase was completely inactivated. In additional experiments, the extent of inactivation of succinic dehydrogenase, as determined spectrophotometrically by the rate of reduction of ferricyanide or cytochrome *c* in the presence of cyanide, was essentially the same as that found with the aerobic succinoxidase determination.

Interpretation of the inactivation of enzyme systems occurring when mitochondria were disrupted is rendered somewhat uncertain by reports of oxygen activation by intense sonic vibrations[13], and by the fact that the preparations were exposed to metal (stainless steel) surfaces during the treatment. In this respect, however, it was found that inactivation of succinic dehydrogenase could not be prevented either by the exclusion of oxygen or by protection of the mitochondria from exposure to metal.

Also shown in the table are the amounts of total nitrogen and enzyme activity recovered in the fractions isolated by low- and high-speed centrifugation after sonic disintegration of mitochondria. Of considerable interest is the finding that an average of 57·7 per cent of the total nitrogen remained in the supernatant (S_2) after centrifugation for 30 min. at 148,000 g. Moreover, this supernatant contained a significant proportion of the cytochrome oxidase and diphosphopyridine nucleotide – cytochrome reductase activity of the original suspension of mitochondria. Most of the remaining nitrogen and enzyme activity was found in Sd_2.

Experiments were then undertaken to obtain further information concerning the composition of the supernatant (S_2). Of the total nitrogen of the preparation, 97 per cent was precipitated by 1·2 M perchloric acid and was insoluble in ethanol; approximately 15 per cent diffused through 'Cellophane' on dialysis for 24 hr. at 2° C. against 0·25 M sucrose. In other experiments the supernatant was dialysed against 0·01 M potassium phosphate buffer (pH = 7·4) until the sucrose was removed, concentrated at 2° C. by placing the 'Cellophane' bag in front of a fan, and studied in the Spinco analytical ultracentrifuge. As shown in the accompanying illustration, there were present at least three components sedimenting at different rates. The observed sedimentation constant for the main component (middle peak in the illustration) was approximately 7·2 Svedberg units; corresponding values for the fast and slow sedimenting components were approximately 12·0 and 4–5 Svedberg units, respectively.

The experiments thus demonstrate that disruption of the mitochondrial membrane is accompanied by the release of a relatively large amount of protein that can be characterized on the basis of rate of sedimentation in the analytical centrifuge. Further investigations of the properties of the soluble proteins of mitochondria will be reported in detail elsewhere.

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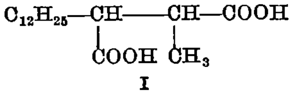
MODIFICATION OF AN ANTI-TUBERCULAR MOLECULE

By DR. VINCENT C. BARRY, J. G. BELTON, ROSE M. KELLY and D. TWOMEY

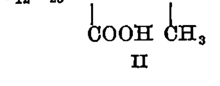
Medical Research Council of Ireland,
University College, Dublin

As already reported[1], the dialkyl-succinic acid (I) shows a very weak inhibitory effect on the growth *in vitro* of *Myco. tuberculosis*, whereas on conversion to the half-ethyl ester, a very active antitubercular molecule is obtained.



$$C_{12}H_{25}-\underset{\substack{|\\ COOH}}{CH}-\underset{\substack{|\\ CH_3}}{CH}-COOH$$

I



$$C_{12}H_{25}-\underset{\substack{|\\ COOH}}{CH}-\underset{\substack{|\\ CH_3}}{CH}-COOEt$$

II

The half-ester was prepared from the anhydride of (I) and consists of a mixture of the two possible isomeric mono-esters (*loc. cit.*). The ester (II) preponderates in the mixture, and for the purpose of this study the presence of the isomeric half-ester has been ignored. In the form of the sodium salt, the half-ester inhibits completely the growth of various strains of *Myco. tuberculosis* for six weeks in horse-flesh broth at dilutions between 200,000 and 400,000.

Incorporation of 5 per cent pooled human serum in the broth reduces the inhibitory dilution to 10,000–20,000.

When given orally to guinea pigs experimentally infected with tuberculosis (*H* 37*Rv* strain), at a dosage-level of 100 mgm./kgm. daily for some months, the sodium salt of the half-ester (designated as *B*.53) produced a 20 per cent increase in survival-time. When injected subcutaneously, it produced very toxic local reactions. A dose of 50 mgm. injected three times a week produced a significant decrease in pulmonary disease in experimentally infected guinea pigs. *B*.53 has now been tried in a limited way in the clinic by local application to tuberculous lesions, and it has been shown to produce rapid healing of tuberculous sinuses and ulcers. When instilled *per catheter* in the form of a buffered solution (0·5 per cent), it has eliminated quickly long-standing tuberculous lesions in the urinary bladder which persisted after nephroureterectomy[3].

This partial success encouraged us to attempt, by suitable modification of the *B*.53 molecule, the synthesis of a substance in which high anti-tubercular potency would be preserved, while reducing considerably the antagonistic action of serum, and thus providing a drug which might meet with a better chance of success on systemic administration. This must not be taken as implying that we subscribe to the widely held view that strong antagonism of the action of an antibacterial substance *in vitro* by serum is *always* a sufficient reason for discarding it without trial *in vivo*.

B.53 is a highly surface-active substance producing hæmolysis of washed human red-blood cells in high dilution. This hæmolytic effect, as well as its antibacterial effect, is very strongly reduced by serum albumin, and it is clear that biological activity can be related to the head-and-tail effect of the long branched-chain and the hydrophilic groupings. It appeared possible that by preserving the branched-chain fatty character of the substance while varying the hydrophilic groups, high biological activity might be preserved while reducing the binding effect of serum. This possibility has been realized by the replacement of the COOH and COOEt groups of (II) by $—CH_2OH$ and $—CH_2NR_2$.

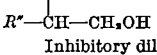
The first modification was effected by the reduction of (I) by lithium aluminium hydride[2]. This afforded the butane diol

$$C_{12}H_{25}—CH(CH_2OH)—CH(CH_3)—CH_2OH$$

III

which had an inhibitory dilution against *Myco. tuberculosis* of 50,000, reduced by serum to 10,000. Other butane diols similarly prepared from *mono*- and *di*-alkyl succinic acids showed no higher activity.

Table 1. Anti-tubercular activity of butan-1, 4-diols *in vitro*



$$R'—CH—CH_2OH$$
$$R''—CH—CH_2OH$$

Diol	No.	Inhibitory dilution (broth)	Inhibitory dilution (serum broth)
$R' = C_9H_{19}$ $R'' = H$	370	50,000 100,000*	20,000 30,000*
$R' = C_{12}H_{25}$ $R' = CH_3$	355	50,000 100,000*	10,000 50,000*
$R' = C_{12}H_{25}$ $R'' = C_2H_5$	389	5,000 150,000*	5,000 15,000*
$R' = C_{16}H_{33}$ $R'' = H$	373	5,000 30,000*	10,000 50,000*

* Dilution allowing full growth as in control. Strain of tubercle bacillus employed: *H* 37*Rv*.

At this stage, a number of propane-diols was synthesized by reduction of the readily accessible alkyl malonic esters by the same reagent:

$$R-CH=(COOEt)_2 \rightarrow R-CH=(CH_2OH)_2$$
$$(R = C_8H_{17} \text{ to } C_{14}H_{29})$$

IV

The best of these was 2-hydroxymethyl-*n*-decan-1-ol (($R = C_8H_{17}$); inhibitory dilution = 30,000; inhibitory dilution (serum) = 20,000)).

A pentane-diol, 4-hydroxymethyl-*n*-tetradecan-1-ol (V, for synthesis, see later) showed somewhat higher activity but was strongly antagonized by serum.

$$C_{10}H_{21}—CH(CH_2OH)—(CH_2)_2—CH_2OH$$

(inhibitory dilution = 75,000; inhibitory dilution (serum) = 10,000)

V

Before attempting further modification of the *B*.53 molecule, it seemed worth while to aim at producing, by further syntheses, branched-chain molecules incorporating an amino-group. The simplest compounds of this type were obtained by lithium aluminium hydride reduction of alkyl cyanoacetic esters:

$$R—CH(CN)—COOEt \rightarrow R—CH(CH_2OH)—CH_2NH_2$$
$$(R = C_{10}H_{21} \text{ to } C_{14}H_{29})$$

VI

These simple amino-alcohols are very much more active than the corresponding diols, and serum antagonism is weak. Thus the compound, 406, 2-hydroxymethyl-*n*-dodecan-1-amine, has inhibitory dilution = 200,000 and only allows full growth at 500,000. Serum reduces these figures to 75,000 and 100,000 respectively. A comparison of these figures (Table 2) with the activities of the corresponding propanediol showed that we were moving in the right direction.

Table 2. Anti-tubercular activity of hydroxy-amines VI *in vitro*

$$R\,CH(CH_2OH)—CH_2NH_2$$

(VI)	No.	Inhibition dilution (broth)	Inhibition dilution (serum broth)
$R = C_{10}H_{21}$	406	200,000 500,000*	75,000 100,000*
$R = C_{12}H_{25}$	372	75,000 300,000*	50,000 75,000*
$R = C_{14}H_{29}$	387	30,000 500,000*	20,000 50,000*

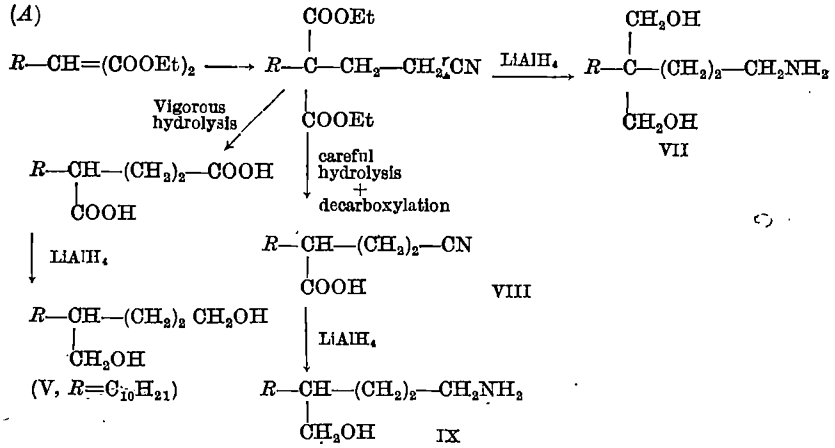
* Dilution allowing full growth as in control. Strain of tubercle bacillus employed: *H* 37*Rv*.

Related compounds containing primary amino- and alcohol groupings were obtained by condensing alkyl malonic esters and alkyl cyanoacetic esters with acrylonitrile (4) and then proceeding according to the schemes *A* and *B* outlined.

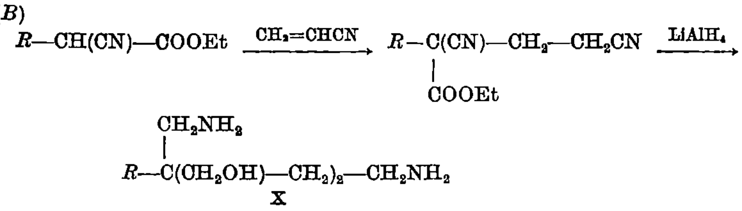
(VII, $R = C_{12}H_{25}$), that is, 4-*bis*hydroxymethyl-*n*-hexadecan-1-amine, has an inhibitory dilution of 100,000, reduced by serum to 20,000, whereas (IX, $R = C_{12}H_{25}$), with one primary alcohol group replaced by hydrogen, has a much greater activity (inhibitory dilution = 300,000; inhibitory dilution (serum) = 100,000). The extra amino-group in (X) again proves not to be advantageous. Thus when $R = C_{10}H_{21}$, (X) has inhibitory dilution = 200,000 and inhibitory dilution (serum) = 75,000. In passing, it is worth noting that the cyano-acids (VIII) are much less active. The compound (VIII, $R = C_{12}H_{25}$) inhibits completely at a dilution of 75,000 and at 10,000 in the presence of serum.

The branched-chain hydroxy-amines (IX) were obviously of great promise, and it became of interest

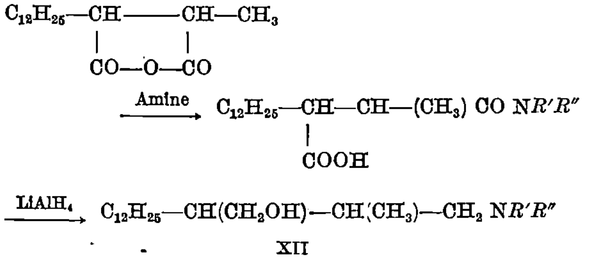
(A)



(B)



to determine whether a similar type of compound with the specific *B*.53 hydrocarbon skeleton would prove to have greater antitubercular activity *in vitro*. Synthesis of primary, secondary and tertiary branched-chain amines containing a —CH_2OH group was attempted according to the following method:



The compound (XI) obtained when ammonia was employed, 2-methyl-3-hydroxymethyl-*n*-pentadecan-1-amine, has not been obtained pure, but exhibits, nevertheless, a considerable antitubercular potency*. It completely inhibits *Myco. tuberculosis* at a dilution of 200,000 and does not permit full growth until a dilution of 2 × 10^6 is reached. Analytically pure oils were obtained when the ammonia was replaced by methyl-aniline and diethylamine. (XII, $R' = CH_3$; $R'' = Ph$) shows low activity (inhibitory dilution = 10,000; inhibitory dilution (serum) = 10,000). On the other hand, (XII, $R' = R'' = C_2H_5$) is very active, producing complete inhibition in broth at a dilution of 500,000 and partial inhibition up to 1 × 10^6. These figures are only reduced by serum to 100,000 and 200,000 respectively. We have therefore succeeded in a planned modification of the *B*.53 molecule which has resulted in a compound which exhibits a somewhat higher anti-tubercular activity in broth than *B*.53 and has ten times the activity in serum broth.

Further synthetical possibilities in this field are being explored. When a sufficient quantity of (XII, $R' = R'' = Et$) has been accumulated, it will be submitted to a trial in guinea pig tuberculosis.

Our thanks are due to our colleagues, Dr. M. L. Conalty and J. F. Chambers, who conducted the *in vitro* tests on these compounds, and to Mr. T. J. D. Lane, for a preliminary account of his clinical experience with *B*.53 in vesical tuberculosis. Grateful acknowledgment is also made to Mr. Max Gergel, Columbia Organic Chemicals Co., for the gift of chemicals.

* *Note added in proof.* We have since obtained evidence that where ammonia or a primary amine is employed in the preparation of the half-amide, subsequent $LiAlH_4$ reduction leads to the formation to some extent of pyrollidine derivatives. Ring closure appears to have occurred also in the synthesis of (X).

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NEW SIMPLIFIED ELECTRON MICROSCOPES

ELECTRON microscopes, of both electrostatic and magnetic type, are now manufactured commercially in several countries. Most of the models on the market have a resolving power in the range 50–100 A., although in the hands of specialists selected instruments have been shown capable of a resolution better than 20 A. However, such tuning-up demands considerable time and experimental skill, and at the same time it is found that most of the applications of the instrument, whether in biology or metallurgy, at present call for a resolution no better than 100 A. Hence there is no great pressure on the designers to produce machines to more stringent specification. Indeed, a survey carried out by the Radio Corporation of America[1] showed that there was an appreciable demand for a machine to cover the range from the normal limits of optical microscopy (about 2,000 A.) to a resolution better by an order of magnitude only. Such an electron microscope could be made simpler and more compact, and thus would be at the same time easier to operate and maintain, and cheaper, than the standard models.

Acting on this consumer survey, the Radio Corporation of America produced a "console model" (Type *EMC*), which is described by Zworykin and Hillier[1]. It proved in practice to be too limited in performance to meet practical needs: the accelerating voltage was low (30 kV.) and the illumination weak, so that only very thin specimens could be observed, and at moderate magnification (5,000). It has therefore had only a restricted use, in spite of attempts to improve it.

Evidence of the need for such a utility model has, however, continued to accumulate with the increasing application of the electron microscope in many fields, and particularly since a number of uses have become sufficiently standardized as to become routine in nature, for example, in particle-size analysis. It was not surprising, therefore, that Metropolitan-Vickers should have followed its recent three-stage standard model (*EM*3) by designing a cabinet model (*EM*4), which was shown last March at the exhibition in London of the Physical Society. More recently the Radio Corporation of America has announced the appearance of a new table model (*EMT*). Both machines have a number of novel features, apart from the general simplification and reduction of cost which place them in a separate category from all other electron microscopes so far produced.

The *EM*4 is designed as a single unit, with high-tension generator, smoothing circuits and vacuum pumps all contained in the same cabinet as the microscope proper and its controls. The *EMT* consists of four separate units, allowing the microscope itself to be separately mounted along with the diffusion pump and some of the controls. The length of the column is kept to reasonable size (30 in.) by dispensing with a condenser lens and employing a moderate magnification (maximum, 6,000). The *EM*4 achieves a column of about half this length, with a wide range of magnification (up to a maximum of 20,000), by using a projector lens having three magnetic gaps in place of the usual single gap. It thus acts as a four-stage microscope, instead of two-stage; the length of column is proportional to the sum of the separate magnifications, while the maximum magnification is given by their product. The resulting short column is fixed horizontally in the top of the cabinet, with the camera chamber at the front end. For visual observation, a magnetic deflecting field throws the image on to an inclined window above the camera. This innovation allows ready observation in a sitting position and simplicity of camera operation; the camera takes either roll film or plates. On the electrical side the *EM*4 incorporates dry rectifiers and voltage doubling in the high-tension supply, in order again to achieve compactness and reduction in cost, as compared with the conventional transformer – rectifying-valve system. In other respects the new model is a simplified version of the *EM*3 instrument, apart from the inclusion of a beam-vibrator for ease of focusing.

The chief technical interest in the new American model, apart from the general design and mounting of the column, lies in the use of permanent magnets instead of energized windings for the objective and projector lenses. A machine of standard type was made some years ago using permanent magnets[2], and von Borries recently described a simpler arrangement[3]; but no commercial model has previously departed from the use of coils for the magnetic lenses. In the Radio Corporation of America design the microscope column is near-vertical, with camera and viewing-window at the bottom end. The magnetic circuit has two gaps, the upper forming the objective and the lower the projector lens. The magnification is fixed, there being no means of varying the reluctance of the circuit. Lens units giving magnifications of 1,500, 3,000 and 6,000 are available. As the positions of both lens and object are fixed, focusing is carried out by varying the accelerating voltage applied to the anode.

Both the new instruments are designed to operate at 50 kV. and to give a resolving power approaching 100 A. The specimen and the photographic plates may be quickly changed, so that the rapid working desirable in routine applications is achieved. If the production models come up to the performance of the prototypes, they will represent an important step towards wider utilization of electron microscopical methods, especially at the technological level. In each case the price is indicated as being around £2,000, which is about half that of the standard models. The specified performance is certainly above half that shown by the latter; the *EM*4, in particular, appears to have considerable flexibility as well as simplicity of operation.

V. E. COSSLETT

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BIOLOGY AND CONTROL OF COCCIDIOSIS

The range of parasitology nowadays is so wide that anyone choosing to work on it soon finds that he must not only have a very broad scientific training, but must also restrict his studies to one field, or even to one genus of parasitic animals. If he be interested in the Protozoa, for example, he may well find that the study of coccidiosis, or even the study of the economic aspects of this disease, will occupy all his life.

For anyone interested in this subject, the conference on coccidiosis convened by the New York Academy of Sciences* provides a sound synoptic view of it. Prefaced by a photograph of, and a short article by, Prof. E. E. Tyzzer, whose classic researches on the coccidia of hen chickens and other birds established the study of coccidiosis for the first time on a scientific basis, the proceedings of this conference cover most aspects of the biology of the species of coccidia considered, their host-parasite relationships and most of the methods used to control the diseases that they cause. The importance of their control is shown by the estimate worked out by one contributor that coccidiosis of poultry costs the United States ten million dollars a year, coccidiosis of cattle the same figure and coccidiosis of sheep half a million dollars, while the disease in goats, pigs, dogs, cats, rabbits and fur bearers adds another half-million dollars to the cost. The total cost of the disease in the United States is thus twenty-one million dollars a year.

It is impossible to summarize in a short space the wide range of this conference. It provides a valuable epitome of every aspect of the subject, and articles on the chemotherapy of the disease and on its nutritional aspects illustrate well the degree to which the parasitologist nowadays has to be, or has to try to be, a biochemist. Although most of the work is American, British research is represented by the article, contributed by Dr. C. Horton-Smith, on factors which influence the origin and course of epidemics of coccidiosis in poultry. The bibliographies appended to each article are a valuable feature of the publication.

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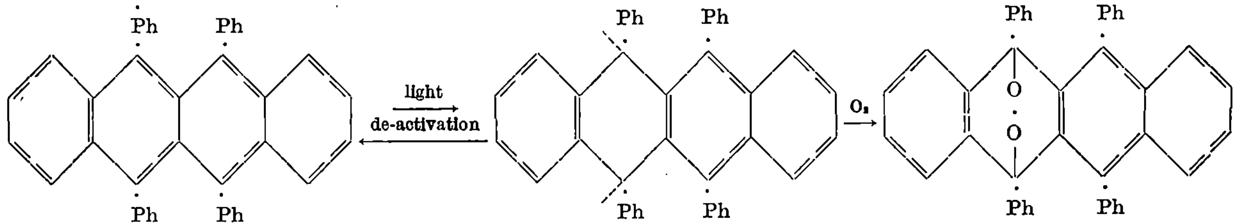
* *Annals of the New York Academy of Sciences*, 52, Art. 4: Coccidiosis. By S. Blackett and forty-two other Authors. Pp. 429–624. (New York: New York Academy of Sciences, 1949.) 3 dollars.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Demonstrability of the Photochemical Formation of Biradicals by Magnetic Methods

THE red 5,6,11,12-tetraphenylnaphthacene (rubrene) (I) is stable to oxygen in the solid state; its solutions, however, are only stable in the dark. When they are irradiated with sunlight or artificial light in the presence of oxygen, a crystalline peroxide (III) is formed[1] (the quantum efficiency of the formation of (III)[2] rises to unity at concentrations greater than 0·01 molar and is independent of wave-length between 3660 and 5460 A.). The easy formation of this peroxide is reminiscent of the formation of (V) from solutions containing hexaphenylethane molecules, as well as their dissociation products, namely, the paramagnetic triphenylmethyl radicals (IV). (The schemes II $\xrightarrow{O_2}$ III and IV $\xrightarrow{O_2}$ V are simplified ones and show in both cases only the initial and final products.)



I II III

$$Ph_3C\text{—}CPh_3 \rightleftarrows 2Ph_3C\cdot \xrightarrow[\text{(dark)}]{O_2} Ph_3C\text{—}O\cdot O\text{—}CPh_3$$

IV V

It has been assumed[3] that light energy transforms the ordinary form of rubrene (I) into a biradical (II), an analogue of triphenylmethyl; it is believed that (II), which should be paramagnetic according to this hypothesis, is able to return to the non-activated diamagnetic state by re-arrangement of the electrons (II → I).

It has been repeatedly stated that the hypothesis of the photoformation of (II) has not been confirmed or has even been contradicted[4] by magnetic measurements, and the criticism is based on Müller's work[5]. According to him, irradiated and non-irradiated solutions of rubrene do not differ in their magnetic properties. No details have been published concerning the photo-experiments, for example, the intensity and nature of the light used in the experiment.

Müller's experiments can, however, scarcely be accepted as evidence against the formation of (III) via a biradical mechanism (comp. II), as the following calculations show that it is very difficult to detect the photochemical formation of activated paramagnetic molecules, in consequence of their low concentration, by the method applied by Müller.

Let q denote the rate of the photo-activation process I → II, x the number of activated molecules (radicals) II present at a given time, both q and x expressed as fractions of the total number of molecules (I). Denote by τ the life-time of a radical (II) before returning to (I); then $1/\tau$ is the probability of deactivation II → I per unit time. One has for the reaction velocity the equation

$$\frac{dx}{dt} = -\frac{x}{\tau} + q,$$

the solution of which satisfying the initial condition $x(0) = 0$ is

$$x = q\tau\{1 - \exp(-t/\tau)\}.$$

It tends to the stationary state $x = q\tau$.

One can estimate that with the sources available for these experiments (300-watt lamp) the number of photons absorbed is about 10^9 per second per mole; hence, as only part of these photons are used for activation, one has $q < 10^{-4}$ sec.$^{-1}$. Hence $\tau > 10^4 x$ sec.

The sensitivity for discovering magnetic radicals ought to be, therefore, better than $x \sim 10^{-4}$ in order to have the lower limit of τ of the order of 1 sec. It is not very likely that life-times of diradicals produced by photo-activation are so long. With the Curie balance the limit of detection is about 1 per cent, $x = 10^{-2}$, hence $\tau > 100$ sec. A life-time of this length would be observable by the retardation of the establishment of equilibrium. In fact, no such time-lag has been observed.

The extremely low concentration of the photo-activated molecules is not inconsistent with the fact that (III) is formed rather rapidly; activated molecules which disappear from the photo-equilibrium (I $\rightleftarrows$ II) in consequence of de-activation or peroxide formation are replaced almost instantaneously; the disadvantage of the low concentration of the activated molecules is counterbalanced by their rapid reformation.

It is hoped that, by the application of a more sensitive method (magnetic resonance may be tried) such as the one used by Müller, the question whether photo-activated organic molecules may be paramagnetic in spite of the fact that the non-activated form is diamagnetic will be solved. This question is also important in connexion with the problem of photo-sensitization[6].

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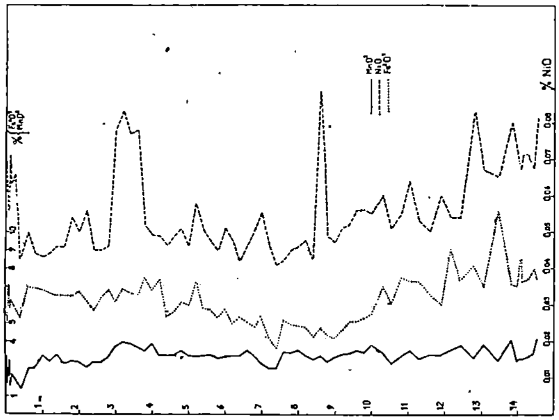
Nickel Content of Deep-Sea Deposits

INVESTIGATIONS made in this Institute of the ferrides present in sediment cores from great depths, taken by the Swedish Deep-Sea Expedition, have shown their content of nickel to be specially interesting. The only analysis of nickel in deep-sea deposits known to us was published in 1914 by F. W. Clarke and G. Steiger, and gave 0·032 per cent as the content of nickel oxide in a composite sample of red clay from fifty-one different localities[1]. By the aid of modern microanalytical methods (the colour reaction with dimethyl glyoxime) quantities of nickel as small as 5–6 γ can easily be measured.

In a core of red clay from the north-west Atlantic Ocean (lat. 30° 29′ N., long. 56° 07′ W., depth 5,620 metres, length of core 1,530 cm.) the content of nickel oxide was found to vary between 0·005 and 0·010 per cent, whereas in a red clay core from the central Pacific Ocean (lat. 07° 38′ S., long. 152° 53′ W., depth 5,000 metres, length of core 1,500 cm.) much higher values were found, ranging between 0·041 and 0·089 per cent of nickel oxide. Assuming the decrease in radium content from the surface layer downwards found in the latter core to be due to the disintegration of ionium, precipitated from the sea-water, namely, a decrease to 50 per cent in 83,000 years, the average rate of deposition in the uppermost parts of the same core would be of the order 0·5 mm. in one thousand years, whereas in the Atlantic core the rate of deposition appears to have been at least ten times higher. The content of nickel oxide in the two cores, therefore, appears to be roughly in inverse proportion to the rate of sedimentation. As is seen from the accompanying graph, where the content of iron-, manganese- and nickel-oxide in the Pacific core is set out as a function of the distance from the top of the core, there are five distinct maxima of nickel content, which do not seem to be related to those of the two other elements.



Vertical axis shows percentage of Fe_2O_3 and MnO_2 (left), and NiO (right); horizontal axis, depth in metres.
———, MnO_2; – – – –, NiO; ……, Fe_2O_3

In another Pacific core taken about 400 nautical miles farther south and in a smaller depth, namely, 4,625 metres, there was also a pronounced maximum of nickel oxide in a 'depth' of 223 cm., namely, 0·098 per cent, which possibly corresponds to the uppermost maximum found in the more northerly core.

Regarding the origin of the nickel found by us in the red clay, three different explanations appear possible:

(1) It may have originated from sea water. This, however, appears improbable, considering the extremely low nickel content in the water (about 10^{-8} per cent or about 500 times less than its content of iron).

(2) It may have originated from magma spread over the ocean floor by submarine eruptions. Thanks to the courtesy of Dr. S. Landergren of the Geological Survey in Stockholm, we have had various specimens of submarine and supramarine lava from the central Pacific Ocean, as well as basaltic rock fragments, taken from great depths in the Indian Ocean by the John Murray Expedition, analysed for nickel by spectrographic precision methods. The results were low, varying between 0·005 and 0·012 per cent. Further, a layer rich in volcanic minerals taken immediately below the layer of maximum nickel content just mentioned was found to have values similar to those of average samples taken from the same core. A magmatic origin of the high nickel values we have found, although it cannot at present be ruled out, appears, therefore, not very probable.

(3) That the nickel may have originated from meteors and from meteoritic dust, on the other hand, seems worthy of serious consideration. Murray and Renard, in their classical studies of the deposits taken by the *Challenger* Expedition, recognized a small number of "cosmic spherules" containing nickel–iron in the red clay and other similar deep-sea deposits. It is reasonable to expect that other fragments from shooting stars in a metallic or oxidized state, as well as minor fragments of interplanetary dust, drifting into the earth's atmosphere, must be present in the deposits to an extent inversely proportional to the rate of sedimentation. A highly approximate calculation, from what we know at present regarding the nickel content and the rate of sedimentation of the cores we have so far examined, leads to unexpectedly high values for the rate of accretion of meteoric material over the whole earth. Our estimates indicate several thousand tons per day (assuming an average nickel content of 2 per cent by weight), which is considerably more than astronomers are at present prepared to admit, on the basis of visual and telescopic counts of meteors entering the earth's atmosphere.

Should a cosmic origin of at least the greater part of the nickel found in the red clay be accepted as a working hypothesis, special interest is attached to the maxima shown by the curve. They might be explained as indicating occurrences of an increased frequency of meteors in the past, possibly due to the solar system travelling through relatively dense cosmic clouds, affording increased chances of capturing comets and meteors.

Investigations now being undertaken will have to show whether such maxima of nickel content coincide with maxima in the number of cosmic spherules, and whether they are of world-wide occurrence. Anyhow, it appears desirable to submit future deep-sea cores to a systematic search for nickel.

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Titrimetric Determination of Nitrates with an Equivalent Ratio of 1 : 8

MANY procedures for titrimetric nitrate determinations are based on reduction by ferrous salts. Ferrous iron reduces nitrates boiled in acid medium to nitrous oxide. In alkaline medium the reduction proceeds at a concentration of 28 per cent sodium hydroxide, and the product is ammonia. Cotte and Kahane[1] have found that silver sulphate catalyses the reduction at a suitably lower concentration of hydroxide. The ammonia formed was distilled into acid, the excess of which was measured. Our method is based on the same reduction ; but the reduced nitrate is measured in another manner. The reduction is effected in a boiling 3 per cent sodium hydroxide solution, containing ammoniacal silver sulphate, by the action of ferrous hydroxide precipitated from a measured sample of ferrous ammonium sulphate. When the reaction is completed, the mixture is acidified with sulphuric acid and the excess of the ferrous iron is titrated with potassium permanganate. A blank titration must also be carried out. The reduction—without regard to the catalysis—proceeds by the following reactions :

(1) $KNO_3 + 2\ Fe(OH)_2 + H_2O = KNO_2 + 2\ Fe(OH)_3$;

(2) $KNO_2 + 6\ Fe(OH)_2 + 5\ H_2O = 6\ Fe(OH)_3 + NH_3 + KOH$.

As can be seen from the equations, 8 moles of $Fe(OH)_2$ are necessary for the reduction of 1 mole of nitrate. 1 ml. of 0·1 *N* potassium permanganate is equivalent to 0·7751 mgm. of NO_3.

Blank : 45·96 ml. 0·1 *N* potassium permanganate

Nitrate taken (mgm.)	0·1 *N* permanganate (ml.)	Nitrate found (mgm.)	Nitrate found (%)	Difference (mgm.)
1·882	43·48	1·922	102·14	+0·040
4·662	39·93	4·674	100·26	+0·012
9·335	33·94	9·317	99·81	−0·018
13·998	27·94	13·967	99·78	−0·031
18·652	21·94	18·618	99·82	−0·034

The largest quantity of nitrate which it was possible to determine amounted to 20 mgm., assuming the use of a 50-ml. burette. This is only equivalent to about 26 ml. of permanganate ; but the ferrous ammonium sulphate must be employed for the reduction in large excess owing to the formation of ferrous - ferric oxide. The fact that the errors of the different nitrate concentrations are quite constant indicates the introduction of correction values.

The ions Al^{3+}, Zn^{2+}, Cd^{2+}, As^{5+}, Sn^{4+}, Mo^{6+}, U^{6+}, W^{6+}, Cl^-, PO_4^{3-}, $B_4O_7^{2-}$, CH_3COO^-, ClO_4^- do not interfere with the method. The interference of the ions : V, As^{3+}, Sn^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Br^-, ClO_3^-, CO_3^-, HCO_3^-, $S_2O_8^{2-}$ can be easily eliminated or compensated.

A detailed communication on this subject will be published in the *Hungarica Chimica Acta*.

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Production of Staphylocoagulase in a Chemically Defined Medium

IN the course of work on the purification of staphylocoagulase, a possible approach appeared to be the production of the enzyme in a protein-free 'synthetic' medium. While growth of *Staphylococcus aureus* occurs according to Fildes *et al.*[1], Gladstone[2] and Gale[3] in media simpler than that reported here, for our purpose, which is concerned exclusively with the production of coagulase, a medium containing a wide range of amino-acids and vitamins seemed advisable. This medium has yielded good growth of a number of freshly isolated strains of coagulase-positive staphylococci, without prior 'training'.

The composition of the medium per hundred c.c. of fluid is as follows : 0·025 gm. each of L-cystine, L-histidine, L-leucine, L-phenylalanine, L-proline, L-tryptophane and L-tyrosine ; 0·05 gm. each of L-arginine, glycine, DL-*iso*leucine, L-lysine, DL-methionine, DL-serine, DL-threonine and DL-valine ; 0·125 gm. of both DL-aspartic acid and L-glutamic acid ; 0·05 µgm. of biotin ; 0·125 gm. each of $MgSO_4.7H_2O$, dipotassium hydrogen phosphate, sodium chloride and ferrous sulphate (crys.) ; nicotinamide, pyridoxine and thiamine each at a concentration of 0·0005 *M*. All constituents were dissolved separately as stock solutions : the amino-acids with the exception of cystine and tyrosine in Sörensen's buffer *p*H 7·3 ; cystine and tyrosine in 3 *N* hydrochloric acid afterwards diluted with distilled water ; salts and vitamins in distilled water. All solutions were sterilized by autoclaving except the ferrous sulphate, which was always freshly prepared and sterilized by filtration through a Seitz pad. The medium, made up by mixing the stock solutions, had a final *p*H of 7. 10 c.c. amounts were distributed with aseptic precautions into universal containers.

The original inoculum consisted of a saline suspension of cells, obtained by repeated spinning and washing of a 24-hours broth culture ; serial subcultures were then obtained by transferring one loopful of growth in synthetic medium. Cultures were incubated at 37° C., samples withdrawn every twenty-four hours and sterilized by heating at 65° C. for 45 min. To 0·5 c.c. of such a killed culture or to a dilution of it, 0·1 c.c. of heparin (containing 10 international units) and 0·2 c.c. of human citrated plasma were added. The mixtures were incubated for twenty-four hours and the sterility of the clots tested by adding 4 c.c. of broth and incubating further.

Coagulase was demonstrated both in the primary cultures and in all sub-cultures. The amount of coagulase was small—not exceeding a titre of 1 : 16 ; this was generally reached after three to five days incubation of the cultures. It has been recently reported[4], however, that purified coagulase shows increased thermolability, and results obtained by one of us (A. J. O'H.) appear to support this. The evidence points to coagulase being present in the medium in a state of relatively high purity and, therefore, heat-sensitive. Thus, the titre of the enzyme demonstrated probably represents only a fraction of that actually produced in the medium. Despite the low titres so far attained, the preparation of staphylocoagulase in a protein-free medium of known chemical composition was thought interesting by itself as an instance of production of a bacterial enzyme under controllable conditions.

We are indebted to the Rankin Research Fund for a grant towards the expenses of the work. We

also wish to thank British Drug Houses, Ltd., Roche Products, Ltd., and British Chemicals and Biologicals, Ltd., for valuable information regarding the amino-acids which they have supplied.

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A Cephalinase in Nervous Tissue

The phospholipids were regarded by the older investigators as relatively inert, and for this reason they have been classed among the 'permanent' or structural elements of the cell. Experiments with the radioactive isotope, phosphorus-32, have shown, however, that the phospholipids of the brain have a significant phosphorus turnover-rate[1,2], and the turnover is greater for cephalin than lecithin.

When sterile rat brain tissue, or a homogenate containing buffer (*p*H 7·5), is incubated at 37° C. in the presence of 1/2,000 merthiolate to prevent bacterial growth, there is a fall in the phospholipid content. Thus in eight experiments the mean phospholipid content of the whole rat brain fell from 4·92 per cent tissue weight to 4·30 per cent in twenty-four hours at 37° C. Determination of the different phospholipid fractions, by methods similar to those described by Hack[3], showed no significant change in the sphingomyelins: the lecithin content fell only from 1·44 to 1·29 per cent, and the main change was in the cephalin fraction, which showed a significant fall from 2·84 to 2·40 per cent.

The decomposition of cephalin is apparently due to an enzyme which splits off the phosphate-containing residue; this is then further broken down by phosphatase action to liberate inorganic phosphate, which could be shown to be formed. The cephalinase has relatively little or no action on lecithin in brain homogenates; for this reason it apparently differs from the lecithinase previously described by King[4].

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Effects of 'Aminopterin' on the Male Sex Organs of the Guinea Pig

Following the interesting communication by Hertz[1] on the decreased growth response of the oviduct to œstrogens in chicks fed on a purified diet without folic acid intake, many reports have appeared lately showing that, in the animals studied, either folic-acid deficiency[2,3] or treatment with 'Aminopterin'[4-7] were able to interfere with the growth response to œstrogens of the female genital tract.

On the basis of these experiments and because of the fact that 'Aminopterin' has been shown to interfere with the ordinary depressive influence of œstrogens on the rat prostate[8], it has been reasonably assumed that folic acid is a prerequisite for the proper utilization of œstrogens. Whether folic acid might also be a prerequisite for the proper utilization of androgens has also been studied; but the results have been discordant. Breudler[8] reported that 'Aminopterin' did not interfere with androgen stimulation of tissue growth in castrated adult and immature rats. On the other hand, Goldsmith and others[9] reported that, in mice fed a crude folic acid antagonist, a reduced response to androgen was evident in the vesicular and coagulating glands.

In the following experiments the effects of 'Aminopterin' on the sex organs of the intact adult guinea pig are studied. The guinea pig was chosen because this animal has no rutting season. Twenty guinea pigs (median weight 600 gm.) were divided into two groups of ten each. Each animal of the first group received 1 mgm. of 'Aminopterin' (kindly supplied by Dr. J. M. Ruegsegger, of the Lederle Laboratories Division of the American Cyanamid Co., Pearl River, New York) intraperitoneally every day for eight days. The animals of the second group received the same amount of 'Aminopterin' for fifteen days.

All the animals in the first group were killed on the eighth day, and the testicles, epididymis, prostate and vesicular glands were studied comparatively with the same organs belonging to five guinea pigs of the same weight used as controls. Grossly, the epididymis, the testicle and the prostate of the guinea pigs receiving 'Aminopterin' did not show any appreciable damage. The vesicular glands, on the other hand, did show an evident decreased size in comparison with the controls. The histological study of the material revealed no apparent change in the testicle; the tubules of the epididymis of some of the animals were almost devoid of spermatozoa, while the epididymis of the controls was overloaded with spermatozoa. In the vesicular glands of the treated animals, the natural infolding of the mucosa was clearly less accentuated than in the controls. Slight signs of atrophy were present in the prostate.

In the second group, although the 'Aminopterin' was given for a period twice as long, the same findings were noticed as in the first group. Hence it may be assumed that the effects of 'Aminopterin' on the male sex organs are not striking if we consider the high doses of the drug being used. In any event, the most evident changes are on the epididymis, which contains less spermatozoa, and on the vesicular glands, which are clearly reduced in size.

I am grateful to Dr. John Mackrell for examining the histological material.

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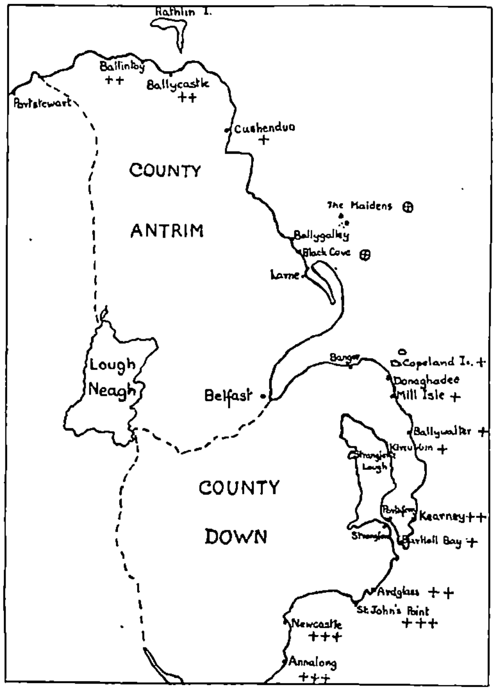
Distribution of *Chthamalus stellatus* on the Shores of North-East Ireland

In a paper discussing the distribution of *Chthamalus stellatus* in British waters, H. B. Moore and J. A. Kitching[1] attempted to link up the distribution of this barnacle with that of Atlantic water. Recently, Kitching[2] suggests that air temperature may be the limiting factor, abandoning to some extent the Atlantic water theory, but adding "although from the known facts the latter is equally possible". Southward[3] has recently recorded the general occurrence of *Chthamalus* in the Isle of Man, and he too points out that there appears to be some correlation between air temperature and the distribution of the species. In the map of Moore and Kitching, *Chthamalus* is unrecorded between Howth and Belfast Lough and given as absent from the east coast of Antrim but as present at Portstewart on the north coast. It was also recorded as absent from the Isle of Man.

Since 1938 I have known of the occurrence of *Chthamalus* in County Down, and it was later recorded by MacDonald[4] from Portlehan near Ardglass. Within the past three months, I have obtained specimens from the following places in Down: Annalong, Newcastle, St. John's Point, very abundant; Ardglass and Kearney, abundant; Bar Hall Bay and Kircubbin (in Strangford Lough), less numerous; Ballywalter, Mill Isle and the Copeland Islands, rather scarce. Although a careful search was made, I have been unable to find *Chthamalus* on the coast of Down north of Mill Isle; but much of this part of the coast is unsuitable for such a high water mark species. A recent examination of County Antrim shows that *Chthamalus* is abundant at Ballintoy and Ballycastle on the north coast, less abundant at Cushendun and present in very small numbers at Black Cove between Larne and Ballygalley. It also occurs on both the larger islands of the Maiden group, but is not at all abundant.



Coastline of Counties Down and Antrim to show the relative abundance of *Chthamalus stellatus*

+++ = very abundant. ++ = abundant. + = present, but not abundant. ⊕ = present, but very scarce

At all the localities where I have found *Chthamalus stellatus* to be abundant, it is commonly found on fairly exposed surfaces above the *Balanus* zone; but at the Copeland Islands, Ballywalter and Mill Isle in northern Down and at Black Cove in Antrim and at the Maidens, it is encountered mixed with the *Balanus* population and is not distinctly above this zone. Furthermore, in these localities it seems to favour the corner of a small crevice or the flat surface of a deep narrow fissure the width of which is just sufficient to allow the barnacle to grow. Such relatively protected sites are commonly found, however, in the narrow upper ends of gullies subject to good wave action. In the Ballycastle and Ballintoy localities it is again abundant on exposed surfaces in the splash zone above the *Balanus* zone.

My observations do not support the theory that it is Atlantic water which favourably influences the distribution of *Chthamalus*, for the colonies at Newcastle, Annalong, Ardglass and Kearney, where *Chthamalus* is abundant, are much less subject to the influence of Atlantic water than are those at Cushendun, Black Cove and the Maidens, yet it can be found in the last two localities only after diligent search. Since the east coast of Antrim is subject to a lower winter air temperature than the coast of Down, it seems more probable that the air temperature is the chief factor controlling the distribution of *Chthamalus*. Moreover, a fluctuating distribution is much more indicative of a variable limiting factor such as air temperature than the degree of Atlantic water, which presumably is approximately the same each year.

I am glad to acknowledge discussions of the question with Prof. R. A. R. Gresson and Mr. R. V. Gotto.

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Breeding and Distribution of *Chthamalus stellatus*

Recent suggestions have been made relating the distribution of *Chthamalus stellatus*[1,2] to low-temperature isotherms. It may therefore be of value to put on record some new observations on its breeding made over the past three years, which have a bearing on present distribution.

Chthamalus is much more widespread in the Irish Sea than is suggested either by Moore and Kitching[1] or by Southward[2]. It has been found to be present along the whole Ayrshire, Galloway, Cumberland and Lancashire coasts as far south as New Brighton (1950). The settlement, even at Blackpool, is not a casual one but contains individuals of large and small sizes (0·2–1·4 cm.) representing probably at least three years settlements. It reappears just south of Holyhead at Porth Dafarch in considerable numbers. The main area of absence on the English coast is thus sharply defined, and limited to the north coast of Wales and Anglesey. Whether this present distribution is the result of two recent warm summers (1947 and 1949) followed by mild winters (since

1946–47), together with a period of rather low average rainfall, or whether the distribution contours of Moore and Kitching were inaccurate for this area can only be decided by subsequent observations, as Moore and Kitching made no direct records between Millport (present) and Leasowe embankment (absent). Their distribution line was determined by reported absences from the Mull of Kintyre and Co. Antrim, an area where conditions, apart from small intertidal range, would all appear favourable; certainly more favourable than on the sandy coast of the Fylde with only few artificial substrata present. Chipperfield[3] has recently re-examined a collection of cirripedes from the upper barnacle zone at Port Erin and Port St. Mary (Isle of Man) taken in 1946, and found the whole of the seven hundred individuals were *Balanus balanoides*. *Chthamalus* would appear, therefore, to have been either absent, quite rare or very local at this time. On the other hand, Mr. H. Powell[4] kindly compared with the present population photographs taken at Farland Point (Cumbrae) in 1946, on which *Chthamali* were clearly visible, and considered that there had been no apparent increase to date, although the general density was actually less than that reported by Moore and Kitching. No significant difference in the position of the limits has been observed either on Anglesey or in the Dorset area during a recent re-examination (1949–50), limits which might be equally liable to variation on account of climatic fluctuations.

Chthamalus starts to breed considerably earlier than previously reported[5], although the occurrence of nauplii during January–March[6] is surely due to confusion with *Balanus balanoides*. In the south-west (Brixham–Penzance) fertilized eggs are to be found in occasional individuals at low-water mark by the first week in April, the onset of fertilization gradually spreading up the intertidal zone, reaching the level of high-water springs by late May. Farther north, fertilization commences only a little later, Westward Ho! (North Devon) in mid-April, North Wales and the Fylde in late April, and Cumbrae (Scotland) in early May. The date of fertilization is also a little later towards the east. Fertilization occurs right up to the limit of distribution wherever individuals are sufficiently close together. Individuals separated by a distance greater than that of the extended penis probably do not fertilize, as is the case in *Balanus balanoides*[3], *Elminius modestus* and *Balanus crenatus*. This feature, probably quite general in cirripedes, is very important in distribution, since fair settlements are necessary before a population can stabilize itself in a new situation. Thus, if environmental factors are marginal, as they may well be for *Chthamalus* in the Irish Sea, the boundary of distribution may fluctuate; but the population will at any one time cover a discrete and distinct area within which there are enough closely placed individuals to maintain the population.

Chthamalus, like *Balanus crenatus* and *Elminius* but unlike *Balanus balanoides* in British waters, gives rise to a succession of broods during its breeding season, the ovaries re-developing as each brood matures. Of these broods, which are liberated as nauplii from early May until late September, only those appearing in the plankton during July–August succeed in passing through the later larval stages and settling. Whatever unfavourable influence operates during the earlier and later months in the south-west may operate for an increasing proportion of the breeding period towards the distribution limits. The vulnerability of the larval, rather than adult, stages is emphasized by the survival of transplants in good condition over the winter of 1949–50 at Whitley Bay even at high-water springs level.

The better survival of *Chthamalus* at high water and in exposed situations with on-shore winds[7] is probably related to its feeding habit. In situations over which wave swash occurs, individuals may be observed feeding not by cirral beat, but by holding the cirri stiffly against the stream, retracting only occasionally (on capture of food ?) or when the water drains off. The adults in such situations are not only more strongly growing but also produce nauplii earlier and at more frequent intervals than do those in sheltered positions.

I wish to thank Prof. J. H. Orton, Dr. P. N. J. Chipperfield and Dr. J. A. Kitching for stimulating discussions on this subject.

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[2] *Nature*, **165**, 408 (1950).

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The Medusa *Craspedacusta* in Australia

The Trachyline medusa *Craspedacusta sowerbii* Lankester (*Mycrohydra ryderi* Potts) has made several sporadic appearances in Great Britain and the continents of Europe and America since it was first described by Lankester[1] from specimens found in the *Victoria regia* tank in Regent's Park, London, in 1880. In 1907, a freshwater medusa under the name of *Limnocodium kawaii* Oka was described from the Yangtse; but this is now believed to be identical with *C. sowerbii*[2].

I believe the following to be the first record of the species on the Australian continent. On March 8 some specimens were very kindly sent to me by Mr. J. Johnston, of the Adelaide Engineering and Water Supply Department. They had been found on the previous day in the Thorndon Park reservoir, which is in the foothills a few miles out of Adelaide. This is Adelaide's oldest and smallest reservoir, having a total capacity of about 138,500,000 gallons. At the time of the find, the reservoir was nearly three-quarters full; in shape, it is more or less circular and has stone-faced revetments. For many years it has had no significant natural inflow but has been used largely as a storage tank, being filled by gravity from other, larger reservoirs in the hills behind it. Like all the other reservoirs in the Adelaide reticulation system, the one at Thorndon Park is carefully examined weekly, so that it is unlikely that an occurrence such as this should have been previously overlooked.

On March 7 specimens were reported as being 'numerous' in the vicinity of the control tower where the inlet valve is housed; but only two specimens were taken for identification. On March 9 a visit by Mr. Johnston disclosed none near the control tower; but eight were found in the surface waters towards the centre of the lake. On March 15 no specimens were seen; but on the following day a dozen or so specimens were caught and as many more seen. None of these was near the control tower or the banks. On March 29 there were still many medusæ present, and those caught were appreciably larger than those taken previously. Their gonads showed a few well-developed ova, but had the appearance of being partly or almost wholly spent. Several of these had as many as three or four semi-digested daphnids in the gastro-vascular cavity. During March, the water temperature has varied between 21° and 22° C. Despite an intensive search, no specimens of the hydroid stage have been found.

Specimens varied in size from a little less than 1 cm. across the disk to nearly 2 cm. All were females. A few have been kept alive in laboratory aquaria for more than three weeks, during which time some grew appreciably and were observed to have fed on daphnids, cyprids and small mosquito larvæ.

It has been ascertained that no new water plants or animals have been intentionally introduced into the reservoir for many years. The only record is of English perch having been introduced soon after the reservoir was established. The possibility of frustules formed by gemmation from the hydroid having been carried in with water from other reservoirs and becoming established at Thorndon Park cannot be overlooked; but no medusæ have as yet been seen elsewhere. How *Craspedacusta* came to this reservoir remains as puzzling as has been its sudden appearances in many other natural and artificial waters in other parts of the world.

I. M. Thomas

Zoology Department,
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April 12.

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Birefringence of Amœbæ

It has been known for some time that the cell membrane of an amœba in water is birefringent. The optical axis lies radially, and the sign is positive with respect to the tangent[1] (Fig. 1). I have found that if an *Amœba proteus* is fixed for about 10 min. in 4 per cent formalin and then immersed in a solution of potassium mercuric iodide of refractive index 1·56, the birefringence of the membrane decreases, and the sign becomes negative (Fig. 2). A similar increase in the negative birefringence of the cell membrane on imbibition with liquids of high refractive index has also been found with red blood cell ghosts[2,3], and with sea urchin eggs[4]. It implies that the membrane has positive form birefringence and negative intrinsic birefringence. I have discussed the implications of this phenomenon, with special reference to the red cell ghost, in another communication[3].

No birefringence can be detected in the axial regions of a pseudopodium, living or imbibed, even with a very sensitive polarizing microscope. This is in contrast to the elongated processes of snail amœbocytes, or tissue culture cells, which show birefringence, the sign being positive with respect to the length of the process (Fig. 3). This birefringence may, however, be due to the stretched cell membrane rather than to the cytoplasm.

There are no striking differences in the birefringence of different regions of the membrane of a moving amœba. Small differences of retardation occur and may be due to changes either of the curvature or thickness of the membrane, or of its coefficient of birefringence. It is impossible to detect any flow birefringence in the fluid cytoplasm.

Teitel Bernard[5] found that the birefringence of leucocyte nuclei was increased by staining. This also occurs with the surface layers of amœbæ. If a living amœba is placed in dilute solutions of certain basic dyes, the birefringence at the periphery is considerably enhanced and the colour becomes a characteristic greenish-yellow. Of the dyes tested, the following were found to cause this enhancement of birefringence: Toluidine Blue, Methylene Blue, Thionin, Methyl Violet, Janus Green B, Neutral Red and Basic Fuchsin. In dilute solutions (down to 1 : 100,000 for Toluidine Blue), amœbæ which showed this enhanced birefringence continued to move about, though their activity was less than under normal conditions.

Although the effect of these dyes on the birefringence is detectable without a compensator, the most striking effect is obtained if a compensator is used. The colour of the birefringent parts of the amœba then changes, and becomes red or orange in one pair of quadrants, and green or yellow in the other pair. The colours in the quadrants are reversed if the sign of the retardation produced by the compensator is reversed. These are not the usual birefringence colours produced in white light, but are due to the dye molecules or aggregates being positively birefringent for one end of the spectrum, and negatively birefringent for the other end[6]. It should be noted

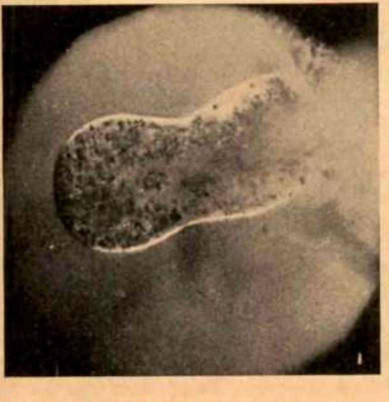

Fig. 1. Living amœba in polarized light. With compensation. × 200

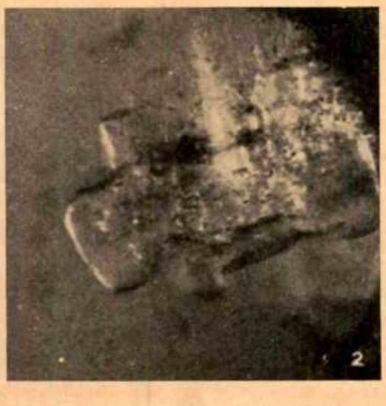

Fig. 2. Formalin-fixed amœba in potassium mercuric iodide solution in polarized light. Same compensation as in Fig. 1. × 400

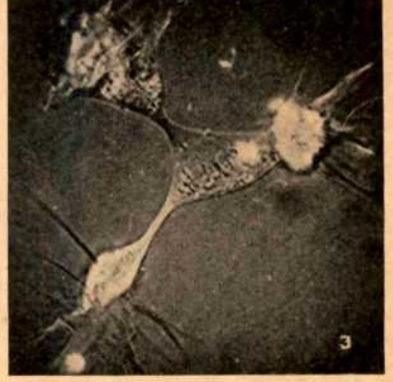

Fig. 3. Living snail amœbocytes in polarized light. With compensation. × 560

that in a few cases these colours are not the same for equivalent quadrants in different parts of one animal. The dyed membrane may then be both red and green in the same quadrant.

The presence of these colours shows that the dye molecules or aggregates are oriented in the living amœba. It seems likely that they are adsorbed on to a labile oriented structure present in the living membrane or cortex. This idea is supported by the fact that the colours vanish at once if the amœba is killed by fixatives, detergents, heat or cyanide. The addition of a weak solution of the detergent 'Teepol' to a dyed amœba in water causes the colours to vanish instantly; but only after a minute or so is there any cytolysis visible under an ordinary microscope. The dye penetrates both living and dead amœbæ, since under an ordinary microscope these appear stained with the normal colour of the dye. Only in the living animal, however, is the dye oriented.

It does not seem possible to reach any detailed conclusions about the orientation of the dyes, or about the structure on which they are presumably adsorbed. The birefringence of dyes has not yet been fully investigated, nor is it known on to what structures, or in what way, are they likely to be adsorbed.

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April 26.

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Preparation of Standardized Actinomycete Colonies

MANY soil actinomycetes of the genus *Streptomyces* inhibit the growth of fungi on solid agar media, the inhibitory power exerted by a colony of such an actinomycete on a neighbouring fungal colony being indicated by the width of the inhibition zone which forms between them. Since the width of this zone is affected by the size and relative positions of the two colonies, it is essential to standardize these conditions in order to compare the anti-fungal activity of an actinomycete on different media. Actinomycetes grow slowly by comparison with most fungi; hence, when making an antagonism test of this type, it is convenient to inoculate the actinomycete over an area of the agar surface upon which will arise a colony large enough to give an easily measurable inhibition zone in a short time. Colonies 5–10 mm. in diameter when three to five days old have been found to be quite suitable. The technique of placing aliquot drops of liquid inoculum directly on an agar surface is sometimes not satisfactory, because the drops may spread, particularly when the plate is moved, thereby giving rise to irregular colonies. Moreover, the amount of spreading is affected by the composition of the medium. Again, it is sometimes necessary to inoculate with the actinomycete after the fungus has grown for some time on the plate. In such cases it is difficult to place the drops at a predetermined distance from the fungal growth.

Standardized actinomycete colonies can be obtained easily with the aid of short open-ended porcelain cylinders similar to those originally recommended for the biological assay of penicillin solutions[1]. Cylinders are dry-sterilized in Petri dishes which are then kept at a constant temperature on a hot plate while the cylinders are being removed for use[2]. A temperature of 100–110° C. is optimal for this purpose. A cylinder at this temperature, when placed end-on to an agar surface, will sink in to a depth of about 0·2 mm. to form a cup which, when quite cool, receives one or two drops of inoculum from a Pasteur pipette.

During the first forty-eight hours of incubation, the inoculum-suspending liquid is absorbed into the medium, leaving the spores or mycelial fragments drawn down into the agar within the confines of the cylinder. When all traces of surface moisture near the base of the cup have disappeared (48–72 hr. incubation) the plates may be inverted for microscopic examination, and for making zone measurements. Since some cylinders will fall off when the plates are inverted, it is advisable to remove them all at this time. A sharp tap on the underside of an inverted plate is sufficient to dislodge a cylinder and allow it to fall into the lid from which it may be removed. Neat circular colonies are left in the required positions on the agar surface. Removal of cylinders from the medium with forceps is not recommended, as this procedure frequently leads to a deposition of spores round about the colony. Provided the inoculum used is sufficiently strong to give a confluent growth on the base of the cup, the sizes of such colonies, their rates of growth and their antibiotic properties vary very little on any one medium. Little advantage is gained by using cylinders to place fungal colonies, since a drop of inoculum too small to spread gives rise to a large and uniform colony. A wire loop 1 mm. in diameter is used for placing a loop of fungal inoculum at the required distance from the actinomycete growth.

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Application of the Kozeny Equation to Consolidated Porous Media

Wyllie and Rose[1] have recently directed attention to the fact that the numerical constant (k) in the Kozeny equation may exceed the value of 5, if one applies a tortuosity correction based on the electrical resistance of the system.

During the last few years, work has been carried out in these laboratories on the electrokinetic properties of the interface between the wool fibre and water, as part of which it has been necessary to determine the radius of the fibre *in situ* by permeability measurements. It has been found that, at porosities of the order of 0·8, k may have values of the order of 6·5, and may be even greater at lower porosities.

It has been noticed in the course of the experimental work that, contrary to expectation, the volume flow-rate was not proportional to the applied pressure. A consideration of the criteria for stream-line flow showed that the linear flow relation will only be found experimentally under the double condition there is streamline flow in the liquid and that lid surface is geometrically smooth. This condition is not obeyed in the case of the wool nd it is likely to be equally invalid for the fluids through particulate beds. The imme- consequence is that a non-linear flow function observed; and it can be shown qualitatively a relation of the Kozeny type will only hold w pressures where the flow is hydrodynamically lar to that over a smooth surface.

n application of these principles to the study of flow of carbon tetrachloride and petroleum ether rough long wool fibres packed randomly in a herical cell and oriented parallel to the axis of a lindrical cell showed that, in the porosity range 82–0·86, the data were independent of the type of cking and followed fairly closely the function

$$\log_{10} k = \text{const.} - b \log_{10} [1/(1 - \varepsilon)],$$

where ε is the porosity of the bed.

It was found that, within the limits of experimental rror, the value of the constant was the same for both quids ($k_0 = 14 \cdot 9$) and that b was inversely proportional to the kinematic viscosity of the liquid. The experimentally determined values of k were of the order of 6·5 and 4·5 for carbon tetrachloride and petroleum ether respectively. The form of the equation for k suggests that its value may be greater at lower values of the porosity.

In support of these arguments, it may be stated that the above relation has been used to calculate the k function for water, which cannot be determined experimentally because of the unknown effect of swelling on the fibre radius[2]. This function has been applied to the calculation of the fibre radius in the presence of a dilute solution of potassium chloride. In the only set of data so far examined, the radius was found to be $12 \cdot 2\mu$ with a standard error of $\pm 0 \cdot 14\mu$, based on the mean of three replicate determinations on the same cell packing. Within the limits of experimental error, this agrees with an estimate based on the direct determination of the radius after free swelling in the salt solution.

In the course of this work, it has been necessary to consider the electrical conductivity of the fibre ads, and, although comment cannot be made on the work of Wyllie and Rose until it is published in full, the following observations may be of interest.

It is a further consequence of the arguments which have been developed that, at moderate pressures, the low-rate per unit pressure may reach a second lower and constant value due to a hydrodynamic condition pproximating to the rectilinear flow of fluid through the bed. The ratio of the two constant flow-rates may be used as an estimate of the fluid dead-space n the bed under rectilinear flow conditions. Now he flow of electric current is essentially rectilinear the case of a conducting solid and, with one rther reasonable assumption, it is possible to write own an expression for the conductivity of the aphragm in terms of the specific conductivities of solid and the liquid. From the data mentioned lier, the ratio of the two specific conductivities found to be 0·2. This compares favourably with value of 0·16 for the salt partition coefficient ween the fibre and the solution, based on measured nges in the chloride ion concentration of the liquid ase.

A fuller account of the permeability investigation ill be submitted elsewhere in the near future; but detailed consideration of the conductivity problem must await the completion of the calculations now in progress.

I wish to thank the Director of the British Launderers' Research Association for permission to publish this note.

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June 22.

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A Modification to Gabor's Proposed Diffraction Microscope

DR. D. GABOR[1] has described a new method whereby an image of an object is reconstructed from a diffraction pattern formed by the interference of the coherently scattered waves from the object and a background wave from a highly coherent source. In the system he suggested, the source is a highly demagnified image of an electron source. The object, small compared with the beam cross-section, is placed closely in front of the aberration caustic, and the scattered wave interferes with the main wave at a photographic plate placed some distance after the object. Reconstruction is carried out in an optical (light) system, which produces an irradiating wave simulating the aberrations in the electron optical system.

Experimental proof of the theoretical predictions was obtained by Gabor and later by ourselves by reconstructing diffraction patterns produced in a light optical system with light.

Experiments have been in progress in this laboratory in close association with Dr. Gabor, with the view of making electron diffraction patterns and reconstructing them with light. The apparatus used follows Gabor's suggestion, and has been realized by mounting the object in an additional mechanical stage after the projector lens of a more or less standard electron microscope. The lens system performs the function of producing the highly coherent irradiating beam.

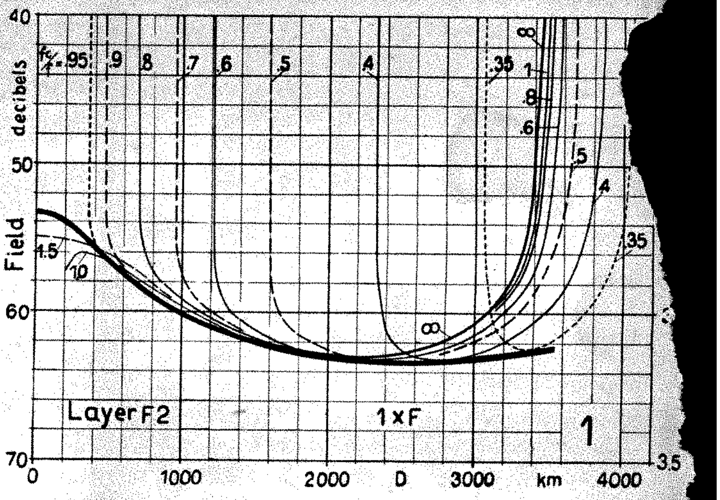
So far, only limited success has been obtained. This has been at least partly due to the fact that the projected image is greatly distorted. Furthermore, the useful field is severely limited by chromatic difference in magnification. These factors render the alignment of the instrument and object very difficult.

It is now suggested that this modified arrangement of the electron microscope is not necessary, and, in fact, that it is advantageous to insert the object in the normal position before the objective lens. An approximate theory of the proposed arrangement has been developed. The diffraction pattern is substantially the same as in the old arrangement, except that no image distortion now occurs and the useful field is no longer limited by chromatic difference in magnification.

The conditions for coherence of the source are met with relative ease by the insertion of an aperture of a few microns in size after the electron gun, or by using a strongly demagnifying condenser lens.

The new arrangement allows the electron optical system to be aligned with comparative ease, and the object can be located by using the instrument as a normal transmission microscope; a photograph may be taken in this condition. The diffraction pattern is then photographed after defocusing the condenser lens to increase the coherence. Reconstruction should then give additional resolution.

It is of interest to note that the state of focus is relatively unimportant in producing the diffraction picture. As the instrument is defocused, more of the information concerning small detail is transferred from the normal image to the diffraction fringes. At focus, all the information which the aberrations allow is contained in the normal image. This we may expect, since the aberrations prevent true focusing. The focused image may be reconstructed to give the improved resolution set by the coherence.



The ultimate resolution possible after reconstruction may be judged from the diffraction pattern by the width of the last and narrowest fringe; this is independent of the position of focus and equal to twice the resolving limit.

It is still a necessary requirement that the object take up only a small proportion of the total area occupied by the background interfering beam. This may be regarded as one aspect of the fundamental coherence requirement.

Reconstruction apparatus for the new arrangement has been considered and does not appear to present any special additional difficulties.

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April 20.

[1] Gabor, D., *Proc. Roy. Soc.*, A, **197**, 454 (1949).

Geometrical Optics of Ionospheric Propagation

Lejay and Lepechinsky[1] recently published a note on field intensity as a function of distance, a question which is of great interest for ionospheric prediction work. With their method of the reflectrix they find two focusing effects, one at a distance corresponding to a path that leaves the earth tangentially, the other at the limit of the skip distance.

The first effect is noted as "an already known fact". In fact, consideration of this effect is one of the fundamental ideas of the ionospheric prediction method, used in Germany during the War (since 1941). I have given a detailed calculation in a report published in 1943 [2], and, since the War, the essential results have been published in France[3]. The second effect was calculated for the first time in an early work of Försterling and Lassen[4], and the same work also contains a theory of the so-called Pedersen-ray.

Meanwhile, a much more complete treatment of the problem has been undertaken[5]. In the case of a parabolic distribution of electron density (earth and ionosphere being curved), the 'geometrical optics' of the ionosphere has been studied by means of an extension of Försterling and Lassen's methods. Theoretically, there are three focusing effects: (1) for the skip distance, resulting from refraction phenomena, (2) for the maximum length of path (tangent ray), due to the curvature of the reflecting layer, (3) for the antipodes, brought about by the spheric form of the earth. The third effect will, in practic be reduced greatly by irregularities of the reflectin layer.

The first effect, which can be very important i certain cases, corresponds to a distance that can never be fixed. For practical use, neither the first nor the third effect can be applied regularly. Th second effect is also influenced by variations of electron density (and layer height). We began by making exact calculations for a given parabolic model of ionospheric layers (limits 240/432 for the F-layer, 100/150 for the E-layer). The various curves of field intensity correspond to all possible ratios of critical to working frequency (f_c versus f) (see graph). We now draw a curve through the lower limits of these curves[6]; this thick curve is used for our prediction work. Thus we find curves for the different paths $1 \times F, 2 \times F, 3 \times F \ldots 1 \times E, 2 \times E \ldots$ For distances of about 20,000 km. the influence of the third focusing effect has been eliminated. The resulting curves are not greatly different from those formerly used[2,3], the influence of curvature being the most important one. Field intensities observed at great distances cannot well be explained, if one does n take this second effect into account.

The work mentioned above[5,6] forms part of the research work of the Service de Prévision Ionosphérique Militaire (France).

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Service de Prévision Ionosphérique Militaire,
Freiburg, Germany.
May 25.

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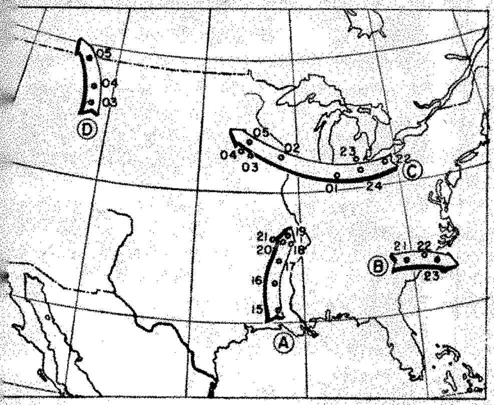
Large-scale Sporadic Movements of the *E*-Layer of the Ionosphere

A WIDESPREAD effort is at present being made obtain information on the prevalence and occurre of sporadic E-layer reflexions over the North Ameri continent. Such information is supplied by a netwo of volunteer radio amateurs (operating in the vicini of 50 mc./s.), upon whose co-operation the succe of the project depends.

ery preliminary results are available, and intention of this short note to indicate ements during the period May 15–16, ., the latest data available at the time of Results [illegible] shown in the accompanying su[illegible]ing *E*-layer reflexions at times [illegible] 1500 G.M.T., May 15, 1949, to [illegible] 1949, inclusive. In this diagram nts the 'centre of mass' of the distinct on shown, and the numeral represents G.M.T. The observed internal consistency single- and double-hop reflexion areas was ying and strengthened belief in the accuracy . It seems premature to attempt determ- equivalent ionic concentrations, inasmuch t theories on sporadic *E*-regions attribute to either a region of high electron density or e of patchy ionic concentration.



ry plot indicating movement of four sporadic *E*-region n areas during May 15–16, 1949. Numbers represent hours G.M.T.

ral limitations on the employment of the data noted. Some bias is inherent in the results unknown observational factors of time . Thus, it is not definitely known what e of, or definitely which, amateurs were 'on prior to 1500 G.M.T.; further, with respect r spatial distribution, the concentration of rs east of the Rocky Mountains is fairly good, t west of the mountains is somewhat sparse. sporadic *E*-regions around the extreme (north th) coastal areas of the continent cannot be ed because of the dearth of shipboard operators rating in this venture. Although it is hoped hey will increase, the present number of volun- bservers in the Dominion of Canada and in o is also somewhat small. Furthermore, the y of observed sporadic *E*-layer reflexion points luenced by the varying number of amateurs ly receiving or transmitting.

should also be realized that a gradual change in de of the reflexion or scattering area, when ed at a single radio-frequency, may indicate ppearance or disappearance of a sporadic *E*- . However, in spite of these limitations, fairly consistent results have been obtained during the interval shown.

examining the results, several interesting effects be noted. At 1500 G.M.T. a few scattered re- on points were observed in reflecting region *A* the Gulf of Mexico. The number of these points ased rapidly during the following hour to form ll-defined area which moved rapidly to the north for the next two hours at an average speed of about 185 km./hr. During 1800–2100 G.M.T. this reflecting area seemed to remain almost stationary and to dissipate in intensity. Dissipation also accompanied a slowing down of reflexion region *C*. While region *A* disintegrated, cloud *B* appeared to form, and, during the next three hours, moved to the east at a speed of about 210 km./hr. Reflecting area *B* was apparently lost as it crossed the coastline.

Region *C* was observed for the greatest length of time. Appearing as a few points at 2200 G.M.T., the number of reflexions increased rapidly until 0300 G.M.T. Simultaneously, a somewhat rapid movement to the west is indicated. The average velocity during 2200–0100 G.M.T. is about 125 km./hr. (from the east). The average velocity of about 370 km./hr. observed, during the next hour, is regarded as doubtful since it is difficult to conceive of an accelerating mechanism of such magnitude during the short time-interval available. The following hour the movement has slowed down to about 210 km./hr., and during succeeding hours dissipation occurs with very little movement. Reflecting region *D* indicates a movement to the north at about 180 km./hr. during 0300–0500 G.M.T.

Whether these results indicate that there is actual atmospheric motion or only electron drift is not certainly known. The possibility of some type of anticyclonic motion in the upper atmosphere is suggested by the combined motion of areas *A* and *B*, and *C* and *D*; but it is far too early to state on the basis of present evidence that such circulations exist.

On some occasions, two amateurs not normally in contact because of distance were suddenly able to communicate for a period up to several minutes or even longer. These contacts were characterized by a sudden beginning of contact and usually by a sudden ending. As meteoric ionization has been known to persist from seconds to minutes and sometimes for as long as several hours, electron clouds caused by meteors may account for isolated instances of long-range contact being reported as due to sporadic *E*-regions.

This study could not have been accomplished without the wholehearted and active co-operation of a great many radio amateurs operating in North America. Appreciation is also expressed to Mr. O. P. Ferrell for screening, and Messrs. R. J. Donaldson, jun., and S. Enderson for plotting, the data.

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Arc Spectrum of Gallium: New Absorption Lines in the Schumann Region

THE list of known terms of GaI as compiled by Bacher and Goudsmit[1], while not very extensive, constitutes the best data so far available. Of this, the series terms are based on Fowler[2], Paschen-Götze[3], and measurements of Uhler and Tanch[4]; the only other terms quoted, namely, $4s4p^2$ ^2S and ^4P, are from Sawyer and Lang[5].

The following points arise with regard to these data:

(1) There are only two known ^2P terms, apart from the ground term. The longest wave-length doublet of the principal series has a calculated position λλ 11,940, 12,096 A., and, judging from Megger's work on infra-red spectra, it should be

possible to record these lines on modern infra-red plates. In addition, there would appear to be no obvious difficulty in the way of extending the series to higher members.

(2) There is an error in Bacher and Goudsmit's tabulation of $8s\ {}^2S_{1/2}$, which by examination of Uhler and Tanch's measurements is seen to lie at 4,048 cm.$^{-1}$.

(3) While the $sp^2\ {}^4P$ term of Sawyer and Lang is scarcely in doubt, the position they suggested for ${}^2S$ of the same configuration is in marked disagreement with that to be expected from identifications in iso-electronic spectra.

Following on the experiments, already reported[6], on the far ultra-violet absorption spectrum of indium vapour, exploratory experiments of similar type have been made with gallium, at temperatures up to 1,620° C. Six intense absorption lines readily appeared on the background provided by the many-line spectrum of H_2, in the wave-length range 1500–1650 A. Four of these are identified as the PP' multiplet $4\ {}^2P^0{}_{1/2\ 3/2}-4s4p^2\ {}^2P_{1/2\ 3/2}$, and the other two, which exhibit the marked diffuseness indicative of auto-ionization, constitute the doublet $4\ {}^2P^0{}_{1/2\ 3/2}-4s4p^2\ {}^2S_{1/2}$.

Approximate positions of the resulting new levels, based on rather rough initial measurements, are:

$$\begin{array}{rl} 4s4p^2\ {}^2P_{3/2} & -\ 18{,}042\ \text{cm.}^{-1}. \\ {}^2P_{1/2} & -\ 17{,}416 \\ {}^2S_{1/2} & -\ 13{,}720 \end{array}$$

A full account of this work, and of experiments in progress, will appear later.

W. R. S. GARTON

Imperial College of Science and Technology,
London, S.W.7.
April 19.

---

[1] "Atomic Energy States" (McGraw-Hill, New York, 1932),

[2] "Report on Series in Line Spectra" (London, 1922).

[3] "Seriengesetze der Linienspektren" (Springer, Berlin, 1922).

[4] Uhler, H. S., and Tanch, J. W., *Astrophys. J.*, **55**, 291 (1922).

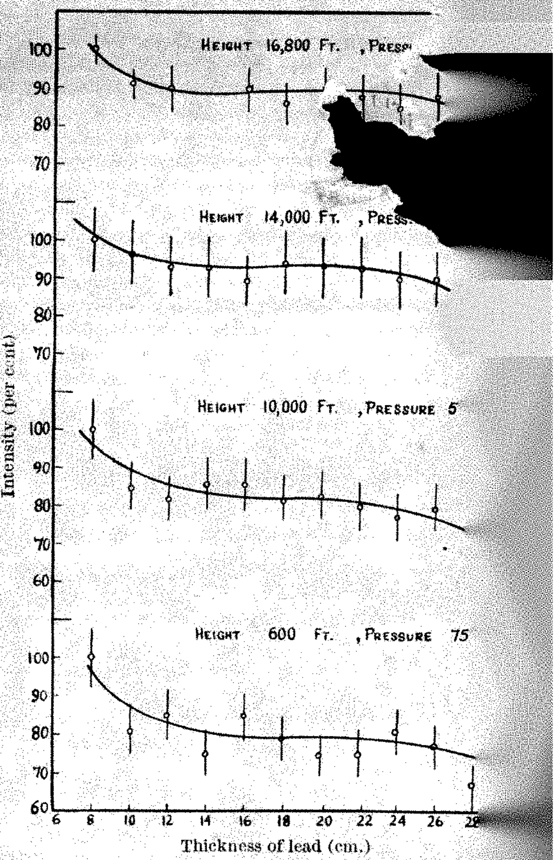
[5] Sawyer, R. A., and Lang, R. J., *Phys. Rev.*, **34**, 712 (1929).

[6] Garton, W. R. S., *Nature* [**166**, 150 (1950)].

Lead Absorption of Cosmic Rays at Different Altitudes near Magnetic Latitude 22° N.

ANOMALIES of the absorption curve of vertically incident cosmic rays in lead have been reported[1-6]. Clay and his associates[1-3] showed the existence of a second and third maximum in the ionization curve at about 16 and 25 cm. of lead. Chandrashekhar Aiya[4] at Bangalore reported a drop in his intensity curve at 21 cm. of lead. Swann and Morris[5] at Bocayuva found a drop at a lead thickness of 22 cm., whereas there was no apparent drop at Swarthmore. Recently, Fenyves and Haiman[7] at Budapest observed anomalies in their absorption curve in lead at 18·2 cm. and 26·6 cm.

In 1945, I made some measurements on the absorption of cosmic rays in lead near magnetic latitude 22° N. at altitudes varying from 600 ft. to 16,800 ft. in the Himalayas. Two similar telescopes consisting of three Geiger–Müller tubes each with slabs of lead interposed, connected together in a coincidence circuit, were used, and thickness of lead above the telescopes was varied from zero to 20 cm. in steps of 4 cm. The solid cones subtended by the two telescopes were the same. The coincidence set connected to the upper telescope measur coincidences for 8, 12, 16, 20, 24 and 28 cm. thicknesses, while the lower one recorded th cidences for 10, 14, 18, 22, 26 and 30 The altitudes tried were 600 ft., 10,000 ft and 16,800 ft. above sea-level.



Absorption of cosmic rays in lead at different elevati

The results are shown in the accompany where intensity (per cent) is plotted against thickness. The general form of the curves i to that of other workers. It may be observ up to a thickness of 12 cm. of lead each curv a rapid decrease, and from there on there appreciable decrease in intensity until the thi of lead exceeds 25 cm. Abnormalities are sh all the four curves. Beyond 25 cm. of lead, int shows a definite drop. This drop occurs at the thickness of lead at all altitudes.

George and Appapillai[6] measured the abso of cosmic rays at Colombo and London at sea Their curves are similar to those reproduced except that the downward bend in their c occurs at 18 and 15 cm. at London and Col respectively. Fenyves and Haiman's[7] data maxima at 18·2 cm. and 26·6 cm., whereas the nearer to sea-level in the present paper ind these maxima with a shift of about two centi to smaller thickness, namely, near 16 cm. and 2 Since these measurements were made for a diff purpose, our statistical accuracy cannot bring the details; but one point is clear, and that is there exists the abnormality in the intensity c in the form of a drop beyond 25 cm. of lead.

There is no doubt that beyond 20 cm. the su drop in the intensity versus lead-thickness cur

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PUBLIC LIBRARIES AND INFORMATION SERVICES IN GREAT BRITAIN

A HUNDRED years ago, on August 14, 1850, the first Public Libraries Act received the Royal Assent, and English and Welsh town councils with a population exceeding ten thousand were empowered to levy a rate up to a halfpenny in the pound for the building or maintenance of a public library but not to spend any of it on books. This piece of legislation is sometimes known as the Ewart Act, in acknowledgment of the services of William Ewart, member for the Dumfries Burgh, who was chairman of the select committee of the House of Commons appointed on his motion in 1849 and whose recommendations led to the Act.

Although it was not the first Act on the Statute Book to deal with public libraries—an Act for the better preservation of parochial libraries in England was passed in 1708, and two county boroughs established libraries under the Museum Act of 1845—the Library Association is very fittingly celebrating the centenary of the 1850 Act as the start of a great social institution which has increasingly throughout the century been of incalculable benefit to the people; public libraries have set many on the road to achievement and hold possibilities which have probably not yet been envisaged, even in the survey of the public library system of Great Britain which Mr. L. R. McColvin made eight years ago. The provisions of the Act were extended to Scotland and Ireland in 1853; and in 1855 a further Act reduced the population limit for authorities or combinations of authorities to five thousand, raised the rate limit to a penny, at which it remained until the Act of 1919 removed any such limit, and permitted expenditure on books. The Act of 1919 gave county councils the power; but, in Scotland, burghs still suffer from the limitation of rate to threepence in the pound.

An admirable booklet* issued by the Library Association in connexion with the centenary well indicates the progress which has been made. There are now 587 library authorities, with stocks of forty-two million books, on which more than twelve million readers borrow to the extent of more than three hundred million volumes a year. To-day only sixty thousand people are in areas without library service, and expenditure has risen from £83,000 in 1878 to £3,177,960 in 1939 and £7,705,000 in 1949. The average expenditure per head of population last year was only 9½*d.* or 3*s.* 2*d.* per borrower. Many libraries already spend twice or thrice that amount or more and give a proportionately better service, while a study by the Library Association shows that at least two shillings per head of population should be expended annually.

All this growth was at first slow, and standards of service still vary considerably. Library services had already been initiated by local authorities in Warrington and Salford, while Liverpool had appointed a Public Libraries Committee before the Act of 1850.

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* A Century of Public Libraries, 1850–1950. Pp. 28. (London: Library Association, 1950.) 6*d*.

Before the end of 1850, Brighton and Norwich had also become public library authorities ; Bolton, Ipswich, Liverpool, Manchester and Oxford followed in 1852, and by 1860 there were twenty-eight, among which was London, represented by Westminster. Later progress was stimulated by the benefactions of Andrew Carnegie and J. Passmore Edwards and by the improvement in educational and social conditions. An important factor has undoubtedly been the work of the Library Association, founded in 1877 and incorporated by Royal Charter in 1898.

Although no other country in the world has achieved such high standards of coverage, the celebration of this centenary is no occasion for complacency. There are too many library services which are inadequate and ill-supported. Mr. McColvin's report left no doubt that, even eight years ago, good libraries were few, and gave an outstanding impression of the unsatisfactory general provision and of a badly organised system which stamps permissive legislation in this field as a comparative failure. Understaffing and inadequate premises, parsimonious expenditure on books and indeed every other item were still rife, and Mr. McColvin described reference library work as the outstanding failure of librarianship in Great Britain.

In its centenary booklet, the Library Association recognizes the necessity for a general raising of standards and that the present variations are a reproach to all. Progressive authorities are spending more than 5*s*. per head of population a year on the library service; but the Association believes that the first condition for good future development is that the provision of adequate services by library authorities should be made compulsory and no longer permissive. There should also be a government department, preferably the Ministry of Education, responsible for guiding, encouraging and co-ordinating the work of local authorities. All local authorities should be assisted financially to develop their library services.

Since the McColvin report appeared, there has been some outspoken comment on various aspects of the library service of Great Britain. The Library Association pamphlet itself recognizes that a good reference library is a necessity in any community. At the Aslib Conference in 1949, Dr. Percy Dunsheath spoke strongly about the inadequacy of present-day reference library facilities in science and technology. Reference library facilities in these subjects he considered were a disgrace to Great Britain, and even the Ministry of Education had not realized the educational value of a highly efficient library in the field of science and technology.

Dr. Dunsheath urged the establishment in the centre of London of a new library of science and technology conceived on the grand scale, using the practical experience and tradition of the Patent Office Library, and at least five times as large. Still more recently, in the second Henderson Memorial Lecture on March 31, dealing with the growth of applied chemistry in Glasgow, Dr. W. M. Cumming, in commenting that reference libraries, particularly in technology, are few and far between and largely
out of date, urged the provision of first-class
libraries of science and technology in all
cities of Britain. There is no first-class
library in technology in all Scotland, he ass
he suggested that the Department of Scien
Industrial Research might sponsor some suc
for disseminating knowledge to those who w
it if it were made readily available.

Dr. Dunsheath and Dr. Cumming were, m
speaking in line with the recommendation
Royal Society Scientific Information Confer
1948 which had urged the Government in the
Kingdom to give increased support to central sc
libraries and information services, in particu
Science Library and Patent Office Library.
same time the Conference urged library com
to give more attention to co-operation b
libraries with the object of reducing unde
duplication and of extending access to a
proportion of the world's literature. It was sug
that co-operation should commence in local
and that regional centres should be linked
national and international systems of intercha

This is in line with Mr. McColvin's advocacy
development of a nation-wide reference serv
the adoption of a deliberate national policy of l
up and strengthening existing special librari
reducing unnecessary duplication, and of gra
extending their range. The proposals of the C
of the Library Association in September 194
gested that the establishment and maintena
those departments of a national library service
can most efficiently be provided for the ben
areas larger than those of library authorities, s
regional reference libraries, inter-library co-ope
and the National Central Library, should b
responsibility of a department of the Central G
ment. Other possibilities of co-operation hav
indicated in the reports of Mr. J. H. P. Paff
of Dr. Marjorie Plant published last year.

Although little, if any, Government action
be recorded during the past eight years, the In
ation Services Committee appointed by the Co
of the Royal Society in July 1948 to follow u
recommendation of the Conference has been
sidering improvements in the national ce
scientific libraries. At the request of the
President of the Council, the Panel on Tech
Information Services of the Committee on Indus
Productivity has made a survey of scientific
technical library facilities, though not in the d
which was suggested in the proposals formulate
1946 for the post-war development of the unive
and research libraries of Great Britain by
University and Research Section of the Lib
Association

The survey fully justified the assertion that
development of technical library
to keep pace with the growth of
and the Panel reported that the
nical libraries are no longer capa
full collections of technical literatu
reasonable facilities for readers. This
industrial and other users in keeping

making use of, scientific results, and a greater measure of co-ordinated action is required. The Panel accordingly recommends the establishment of a scientific and technical library authority as a semi-independent agency of the Government to run central and reference libraries, and to advise and assist financially other technical libraries. Its first duty would be to develop a central reference library in London, if possible in close association with specialized libraries of the learned societies, and to develop a national lending library of science and technology, though not necessarily in London.

The Panel considers that the existing Patent Office library might form the basis of the proposed central reference library, and that the existing library of the Science Museum might form the nucleus of the lending library. Better use of the scientific literature in the British Museum Library should also be facilitated. The development of comprehensive scientific and technical sections in public libraries, particularly in the main industrial centres, is also recommended, thus in effect endorsing the recommendation of the McColvin report for the development of regional reference libraries, though the need for a thorough and realistic survey of the whole field of special and non-public libraries is not so clearly recognized, at least in the summary of the report given in the Third Report of the Advisory Council on Scientific Policy.

While agreeing with the diagnosis and broad objectives stated by the Panel, the Advisory Council is not convinced that the case for an executive scientific and technical library authority is established, and considers that the objects in view could be achieved by existing organisations, given effective co-operation and increased support for their efforts. The Advisory Council has accordingly decided to constitute a Standing Scientific Library and Technical Information Committee of the Advisory Council on Scientific Policy. This Committee will be responsible for co-ordinating the development of scientific libraries as a whole and considering in greater detail the parts to be played by individual libraries. It will examine their additional requirements in the light of the needs of users and review the recruitment and training of scientific librarians. It will also initiate and co-ordinate the preparation of union lists and devise and introduce as soon as possible a system of common or interchangeable reader's tickets for those libraries where tickets are required.

In a written Parliamentary answer on July 24, announcing the Government's acceptance of recommendation from the Committee on Industrial Productivity that it should be discharged, the Lord President of the Council confirmed that the Standing Scientific Library and Technical Information Committee set up by the Advisory Council on Scientific Policy would take over the co-ordinating functions hitherto exercised by the Panel on Technical Information Services of the Committee on Industrial Productivity. Without the co-operation of the public libraries the national system of reference and lending libraries in both science and technology desiderated above is unlikely to be built up speedily and efficiently. This undoubtedly is the aspect of public library service of main interest to the scientific worker, though it lies partly outside the sphere of the public library service of the country as inaugurated by the Act of 1850. Clearly the public library service could not well develop one side of its work out of proportion to or at the expense of the rest of its activities. Nevertheless, the value to the economic development of the country of such an extension of the resources of the public libraries for the study of science and technology, whether in their reference or in their lending sections, constitutes a sound reason for more generous Government support of a general expansion. It would be a fitting recognition of the worthy achievements of the first century of the public library.

There are other and more general claims of the public library system on the interest and support of the man of science. If the supply of books is less difficult than during the war years, it is probably still true that both the student and the general reader are dependent to a larger extent on the public library for the books they wish to read than they were before the Second World War. Many standard and classical works are still unobtainable by purchase, although as Sir Stanley Unwin points out in a recent pamphlet, "How Governments Treat Books"*, British restrictions on imports of books except from the hard-currency countries are no longer formidable.

The attitude to books which Sir Stanley attacks in this pamphlet as hindering their free interchange is equally applicable to the extension of public libraries. While post-war governments treat books with the scant respect which Sir Stanley describes, we cannot be optimistic about their encouraging other means which assist the flow of knowledge and of the understanding of one people by another. Furthermore, just as, when books are rare, the importance of the public library which holds them is enhanced, so the present difficult position of the newspapers of Great Britain increases the importance of the reading rooms of the public libraries.

Of the difficult situation in newsprint which has developed in Britain through the mishandling of supplies by the Board of Trade, no more need be said here than that, even if the action now promised by the Government does, contrary to the view of the Newsprint Supply Co., avert the immediate threat of smaller newspapers, British newspapers are still far too small to do their duty to their readers or advertisers, even if they eschewed more rigorously any appearance of waste on the frivolous or trivial. They cannot always supply their readers with the information that is essential for the formation of sound public judgments, even for those who can give the time and trouble to a comparative study of several papers in a public reading room. On that ground alone, while the Government's own policy and control over newsprint supplies prevents the British Press from returning to a size where it could keep its readers well informed on public affairs, it is imperative that the Government should do all that is possible to mitigate the ill-consequences of its own policy.

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* How Governments Treat Books. By Sir Stanley Unwin. Pp. 10. (London: George Allen and Unwin Ltd., 1950.) *6d.* net.

The centenary of the passing of the first Public Libraries Act is a reminder of one direction at least in which an enlightened and generous policy could do something to promote both the development of the public library system in Great Britain and the formation of instructed and intelligent public opinion on the critical affairs of our time.

ANATOMY OF THE FLOWERING PLANTS

Anatomy of the Dicotyledons

Leaves, Stem and Wood in relation to Taxonomy, with Notes on Economic Uses. By Dr. C. R. Metcalfe and Dr. L. Chalk. Vol. 1. Pp. lxiv+724. Vol. 2. Pp. v+725–1500. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 126*s*. net.

IN 1671 Nehemiah Grew presented to the Royal Society a manuscript entitled "The Anatomy of Plants Begun", and since that time a vast quantity of information on this subject has been accumulating, more especially during the past fifty years. The present great work by Dr. C. R. Metcalfe and Dr. L. Chalk summarizes present knowledge of the anatomy of the leaves, stems and wood of the dicotyledons and is worthy to rank with Grew's treatise as a classic of botanical science. Botanists throughout the world will be grateful to the authors and to their assistants, Dr. M. M. Chattaway, Dr. C. L. Hare, Miss E. M. Slatter and Mr. F. R. Richardson, for the many years of labour devoted to the production of this monumental work, to their colleagues at the Royal Botanic Gardens, Kew, and the Imperial Forestry Institute, Oxford, where the materials for study have been collected, and to the staff of the Oxford University Press who have printed so excellently these two large volumes.

The prototype of the work was produced by Prof. Solereder and printed in Germany in 1898. It was translated and brought up to date by Boodle and Fritsch in 1908, and was found to be of considerable value to taxonomists and others as a book of reference. But its general utility often proved to be limited because, while devoting much space to details of minor characters, such as the shape of hairs or of crystals found in certain cells, it provided little detailed information about the structure of wood and other features now considered to be of major importance. In the present volumes the observations of Solereder have been considerably condensed and greatly augmented, so that we have virtually a new book.

The main body of the work occupies fifteen hundred closely printed pages in which the vegetative structure of many representative members of the dicotyledonous families is concisely summarized. For each family the information is arranged under the following headings: a general survey of the characters of the vegetative structures and the wood anatomy; details of structure of the leaf, the axis and the wood; anomalous structures; taxonomic notes; economic uses; list of genera studied; literature. While much of the information comes from the observations of the authors, 2,512 references are given to work published since 1908, which, with the literature list in Solereder's work, constitute a comprehensive bibliography of the subject.

The collection and arrangement of the information reflects the modern trends of botanical thought, so that the work is valuable for purposes other than the identification of plant material. In Solereder's time the study of plant anatomy was regarded as a separate discipline with little bearing on plant morphology and physiology; now the different branches of botany have become more closely integrated, and the evolutionary morphologist regards anatomical structure as one of his most valuable sources of information. This change in outlook is well shown in the introduction, where more than thirty pages are devoted to a survey of the progress of anatomy in relation to phylogeny. This valuable summary shows how the study of wood anatomy has provided a basis for views on the evolution of the dicotyledons which are much less open to criticism than theories based on the supposed form of primitive flowers. Assuming that the type of wood found in the gymnosperms is more primitive than that found in the dicotyledons, statistical correlations show which families of flowering plants are likely to be the more primitive and which the more advanced. The application of this method of correlating characters, both vegetative and reproductive, and checking the results when possible with the evidence shown by fossil plants[1], seems likely to bring us nearer to a solution of the problems of the evolution of the angiosperms. Drs. Metcalfe and Chalk have now provided a great fund of information for further studies on the correlation of vegetative characters. Their lists of families in which certain diagnostic characters occur are easier to use than those in Solereder, since they are now printed in tabular form.

The value of anatomical characters in taxonomy is well illustrated by the Rosaceæ. In current systems of classification, this family includes a group of trees and shrubs, chiefly found in America, distinguished as the Chrysobalanoideæ. The latter are stated to be "very uniform in structure and so distinct as to be easily separated from the rest of the Rosaceæ". More than thirty years ago, Juel studied the development of the carpels in the Rosaceæ and found that the carpels of this sub-family originated in a way totally different from that seen in other members of the family. He thought that this showed that the genus *Parinarium* and its allies should no longer be grouped with the Rosaceæ. Although Juel's work seems to have received little attention from taxonomists, it is now clear that his view was fully justified.

Two of the difficulties attending a study of the comparative anatomy and morphology of the flowering plants are the vast number of forms which might be studied and the problem of selecting a representative range of material. Investigations have often been made on the structure of the plants readily available to the worker, and have led to conclusions which were incorrect or inadequate because the forms that were studied were drawn from a restricted range of plants. In the past, much of our knowledge of the anatomy of dicotyledons was based on the study of the herbaceous forms, which probably represent a highly specialized type. The present wide survey should greatly assist workers to select a more complete range of forms possessing the characters which it is desired to study.

While appreciating the value of these two volumes in furthering the more general aspects of plant anatomy and morphology, one must not forget that the main purpose of the work is to assist those who have to deal with plant material in the identification of their specimens. Those working with timber should obtain considerable help in the identification of hardwoods, based on the study of no less than eighteen hundred species. The details of the structure of leaves and young stems should be of value to those who are examining material imported for use as drugs, flavourings, or other purposes, while the systematic botanist and forester will be supplied with a wealth of information useful in the identification of trees and herbs. The authors have spent ten years in the compilation of the material in this monumental work, and it is not likely to be superseded for very many years. H. HAMSHAW THOMAS

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[1] Sporne, *New Phytologist*, **48**, 259 (1949).

BACTERIAL DISEASES OF CROP PLANTS

Manual of Bacterial Plant Diseases

By Dr. W. J. Dowson. Pp. viii+183+32 plates. (London: Adam and Charles Black, Ltd., 1949.) 16*s*. net.

THE honest student of plant pathology will readily admit that there are considerable gaps in his knowledge of bacterial plant pathogens. This is at present no reflexion on his professional zeal, for, since the classical work of Erwin F. Smith, there have been few available collected works on the subject. Methods have, moreover, advanced apace, and knowledge of diseases has increased very greatly. Dr. W. J. Dowson, having experienced this lack of accumulated literature while lecturing, very rightly decided to remove the incubus. He is well qualified to do this, having been, for many years, the specialist to whom almost all the plant pathologists in Great Britain have referred problems on bacterial disease. The result is a thoroughly helpful and authoritative volume.

Perhaps the number of bacterial maladies may seem [illegible] the crop producer; but it should be remem[illegible] Dr. Dowson has drawn a very compre[illegible]. Many diseases are described which bring [illegible]ble loss in one country but cause little [illegible]ge in others. All the known bacterial maladies [illegible]curring in Britain, and most of those important in the British Dominions, Colonies and Dependencies are included; but a few diseases, recorded so far only from the United States of America, are either omitted or but briefly mentioned. The method of bacterial classification is the author's own modification, but most generic names are already familiar in Great Britain.

A section on methods assumes a knowledge of routine basic methods; but it then becomes a very useful and modern exposition, with all the simple practical features usually developed only by the enthusiast. The platinum needle has, for example, given place to a thin glass rod, with advantage when streaking out plates. Forty excellent half-tone figures illustrate methods, bacteria and disease symptoms, while eighteen world-distribution maps prepared by the Commonwealth Bureau of Mycology make useful contributions in this new setting. Methods for control draw largely on the preventive implications of cultural hygiene; but practical control is probably the least satisfactory section of the subject. This is no criticism of the author or of the book, but rather the *cri de cœur* of an advisory officer at his relative impotence in the face of increasing incidence of bacterial soft rots on agricultural crops. Hygiene is difficult under those conditions, and treatment of dormant organs impracticable.

Plant pathology is, however, only now celebrating the centenary of its inception, and merely its coming-of-age as a vigorous science. Dr. Dowson's book should provide the basis for a considerable impetus to the study of bacterial plant diseases. JOHN GRAINGER

INTENSIVE CULTIVATION OF VEGETABLES

Intensive Salad Production

Including some Vegetables. By C. P. Quarrell. (Agricultural and Horticultural Series.) Fourth revised edition. Pp. xviii+277+16 plates. (London: Crosby Lockwood and Son, Ltd., 1949.) 15*s*. net.

TO the commercial grower and to the student a new edition of C. P. Quarrell's book is a matter of some importance. This is something more than a mere revision of the earlier editions; it is almost a new book. There could not be a better illustration of the rapidity with which horticultural knowledge has grown since the Second World War than the changes which four years have necessitated in the text. Up to 1945 (the date of the third edition) intensive salad production meant almost exclusively the Dutch-light systems pioneered in Great Britain by Mr. F. A. Secrett. Since that date a multitude of other types of protective devices have appeared—cloches, frames and structures of different kinds, sizes and shapes in bewildering variety—and many of these have proved themselves of economic value to the commercial grower. Their adoption has meant new cropping systems and the introduction of a greater diversity of crops into the rotations, and new varieties of plants have been produced to meet the changed needs.

The introduction of entirely new synthetic insecticides and fungicides, the astonishingly rapid growth in the use of overhead irrigation and the development by the British Electrical and Allied Industries Research Association of low-voltage electrical methods of soil warming have all made this new edition imperative. There is scarcely any branch of horticultural production to which the results of war-time and post-war research have been more usefully applied than to protected cultivation. Quarrell's book has become the standard reference for the grower and the chief source of study in this field for the student, and he has earned a debt of gratitude by preparing this careful revision. The photographs and diagrams have been most carefully chosen to illustrate the text; but the addition of a few diagrams to illustrate the section on soil warming by electricity would have been of great value.

For ease of reference it would be an improvement to divide the section on diseases into two chapters and to print the name of the host plant in larger type than that of the parasite. Though cultivation of salad crops in glasshouses is dealt with, no mention is made of the new insecticidal smokes and continuous-phase aerosols which show so much promise in labour saving. Not the least valuable part of the volume as a reference book is the final section of tables, miscellaneous data and selected references to the literature, which bring together much that is so often difficult to find. R. H. STOUGHTON

RECENT ADVANCES IN PHYSICS

Reports on Progress in Physics
Vol. 12 (1948–49). Pp. iii+382. (London: Physical Society, 1949.) 42*s.* net; to Fellows, 25*s.* net.

IN recent years almost every branch of physics has been expanded considerably. Furthermore, the volume of scientific publications has increased to such a large extent that even the specialist in the narrowest field finds it difficult to keep in touch with the rapid developments in his own subject. To follow, in addition, major advances in other important branches of physics is practically impossible. The need, therefore, for the publication at frequent intervals of specialist surveys and reviews of the different fields of physics, such as those provided by "Reports on Progress in Physics", could not be greater. The welcome return, with the publication of Vol. 11 in 1948, the present work in 1949 and the appearance of Vol. 13 in the very near future, to the annual series from the temporary two-year volumes is not only a matter for congratulation but also indicates that the Physical Society is fully alive to the growth of physics and the needs of physicists.

As in previous volumes, the fourteen articles contained in Vol. 12 are authoritative and masterly contributions written by well-known experts in their respective subjects. It is a moot point, however, whether the author of a report should consider his reader to be a specialist worker in that particular field or a trained physicist seeking an insight into, and understanding of, the recent advances in other branches of physics than that peculiarly his own. Both kinds of reports would be equally useful. It is impossible, however, to tell from the title alone into which of these two categories any one of the reports of Vol. 12 falls. In some, as a welcome innovation, a contents list has been provided, and in a few, also, an abstract, so that an idea of the scope of a particular report can be obtained at a glance. But it is a pity that the editor has not insisted on uniformity in this connexion. The provision of an abstract is most helpful, if not essential, and the insertion, at the editorial stage, of a contents list for each report is surely a simple matter.

As usual the contributions cover advances in both the experimental and theoretical fields. On the experimental side there are articles on mass spectrometry; nuclear paramagnetism; phosphors and phosphorescence; nuclear experiments with high-voltage X-rays, in which nuclear physical experiments carried out with betatrons and synchrotrons are described; linear accelerators in which both electron accelerators and the standing-wave proton accelerator are dealt with; and on low-temperature physics in which K. Mendlessohn very rightly restricts his attention to the recent advances in technique and to the two physical phenomena peculiar to low temperatures, namely, superconductivity and superfluidity.

On the theoretical side the volume contains several reports of interest, including one on the theory of oxidation by N. Cabrera and N. F. Mott, and one on collisions between atoms and molecules at ordinary temperatures by H. S. W. Massey. In addition, there are two rather longer articles which are more of the class of monographs than reports. The first, by E. Orowan, is on the fracture and strength of solids. In some forty-five pages, after outlining the main types of fracture, a detailed discussion is given of ultimate stress and necking; brittle fracture, ductile fractures and notch brittleness; fatigue; intercrystalline fractures and fracture by molecular sliding. The second, which is even longer, is by J. de Boer, on molecular distribution and the equation of state of gases. Both the kinetic method and the method of statistical mechanics are clearly explained. A section of a more practical nature follows, and, in order not to lengthen the treatment too much, only the application to the calculation of the distribution-function and the caloric and thermal equation of state of gases, and the properties of systems in equilibrium are discussed.

Three other reports call for special comment. The first, "Spontaneous Fluctuations", by D. K. C. MacDonald, will be of interest both to pure and electronic physicists. It is an account of 'noise' in electrical circuits, in valves and in semi-conductors. Particular attention is paid to the most recent developments. The second, by G. O. Jones, on viscosity and related properties in glass, which was originally presented before the Physical Society as a lecture survey on February 15, 1946, should appeal to the general reader as well as the glass technologist. The flow properties of glass are of obvious practical importance, but, since glass can be regarded as a liquid even at temperatures where it most closely resembles a solid, it is also of considerable theoretical interest. The structure and general properties of glass are briefly considered, and then the significance of phenomena in the transformation region. Finally, the report by M. Ross and J. S. Story on slow-neutron absorption cross-sections of the elements is nothing more than a list of published declassified numerical values, and, though of considerable value, seems out of place in "Progress Reports".

All the excellent features present in previous issues appear in Vol. 12, including the extensive bibliographies, the author index, the clear line-diagrams and beautifully reproduced photographs. The paper, printing and binding are of the highest standard and similar to those of the Physical Society's *Proceedings* and its other publications. The "Reports" are an essential reference work, and no library or active physicist can afford to be without [illegible]

S. WE[illegible]

AN ALPHABETICAL GUIDE TO ATOMIC ENERGY

Pocket Encyclopedia of Atomic Energy
Edited by Frank Gaynor. Pp. 204. (New York: Philosophical Library, Inc., 1950.) 7.50 dollars

THIS book consists of about two thousand definitions or short explanations of terms which are commonly used in discussing atomic energy and nuclear physics. The entries vary in length from a few words to a few pages, and are supplemented by about thirty-five diagrams and tables. There are also brief descriptions of some of the more important nuclear research laboratories and biographical sketches of a few well-known men of science. German equivalents are given for the majority of the terms which have been included.

The intrusion of highly specialized expressions from nuclear physics and engineering into wide fields of politics, administration and technology fully justifies the preparation of such a glossary. Many persons whose education was not scientific, or whose technical training was received when nuclear physics was an abstruse speciality, now find themselves compelled to understand and use a great number of terms which are defined in this volume. A work of this kind should therefore be clear, comprehensive and accurate, and should confine itself to its own subject. There do not appear to be many omissions in the fields of physics and engineering, though *nuclide* and *thermal column*, for example, are missing; I have the impression that the chemical and biological sciences are not so well covered. The standard of writing varies very greatly. The majority of the entries are well expressed and, considering the limits imposed by brevity and simplicity, are not misleading. Some parts, however, sink far below the standard required in a work of any scientific pretensions. Thus, the most important portion of the description of Geiger–Müller counters runs as follows: "The modern version of this counter is an oblong box with headphones attached to it. When a fast alpha or beta particle enters the apparatus, it produces ions in the gas contained in it, and ions cause a loud tick to be heard in the headphone; the ticks are counted automatically by a mechanical device. A modern Geiger–Müller counter can count several hundred thousand particles per minute." It is a pity that much careful work should be marred by such lapses.

The standard of accuracy is not as high as one has a right to expect; nine misprints or errors were found in fifty entries which had been selected more or less at random. Most of the information is creditably up to date; but it is not always as authentic as possible. For example, Seaborg and Perlman's Table of Isotopes (*Rev. Mod. Phys.*, 20, 585; 1948) is not mentioned, and the properties of the radioactive nuclei are quoted from a medical text-book. In a future work of this type, in which a really authoritative treatment is plainly impossible, it would probably be worth while to give references, wherever possible, to standard text-books or to review articles. At present a reader who wishes to inquire further has no idea where to begin.

The price of this volume is almost prohibitively high for the 'sterling' reader. It must therefore be regretted that so much space is devoted to duplicating information which can be found in any chemical dictionary. In so rapidly changing a field, and one in which the latest developments are of interest to a larger public, a smaller book, more easily renewed, would have been preferable.

W. J. Whitehouse

PRESENTATION OF INORGANIC CHEMISTRY

The Chemical Elements and their Compounds

By N. V. Sidgwick. Vol. 1. Pp. xxxii+854. Vol. 2. Pp. vi+855–1704. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 70*s*. net.

THE presentation of inorganic chemistry to the undergraduate and research worker raises problems of peculiar difficulty, for the mass of factual detail which has accumulated tends to obscure the general principles which are gradually emerging. At the same time a certain amount of detail is inevitable, if only by way of illustration of principles. Prof. N. V. Sidgwick has approached this problem by omitting almost completely mineralogy, metallurgy and technical and analytical chemistry. With this simplification, the elements are then dealt with in turn on the basis of the Periodic Table, those of Groups I–V in the first volume and the remainder in the second volume. Some of the elements, such as boron, phosphorus and a number of the metals, are treated individually; but certain groups of closely related elements, such as arsenic, antimony and bismuth, or the halogens, are taken together. This has enabled special emphasis to be placed on comparative chemistry and the variations in properties within the groups. Problems of interest in connexion with valency and structure are brought well to the fore, as are the many instances where further investigation is needed. The author has succeeded completely in his aim of emphasizing principles: the remarkable thing is that he has also included a tremendous amount of interesting descriptive chemistry without at any point overburdening the text with detail. The treatment of carbon is particularly valuable, for not only has it taken its place as a normal element, but also a good deal of space is devoted throughout the book to organic derivatives.

Numerous references are given and their arrangement at the foot of each page is very convenient. The literature survey has been completed up to the summer of 1948. Only in the case of a few topics, such, for example, as the chemistry of the transuranic elements and the use of lithium aluminium hydride, where recent progress has been unusually rapid, are there significant omissions. The index is good, though it would have been more convenient had it been printed in full at the end of each volume, instead of in the second only.

Criticism of the author's choice of material can only be a matter of personal opinion. Some readers may, however, regret that so little reference is made to the experimental aspects of inorganic chemistry. One finds very frequently, especially among undergraduates, a more or less adequate knowledge of facts and theories, but a complete ignorance of how any but the most elementary experiments are done. Another point on which comment is perhaps justified is the very slight emphasis which is placed on physicochemical aspects of the subject, such as the significance of oxidation-reduction potentials and equilibrium data. Structural inorganic chemistry is also given little prominence, but one feels here that the author may have expected the reader to have available A. F. Wells's excellent book on this subject, which was published in 1945 by the Oxford University Press.

The book reflects accurately Prof. Sidgwick's lifelong interest in chemistry as a whole. For undertaking this task and bringing it to so satisfactory a conclusion he deserves the particular gratitude of those who teach inorganic chemistry. The subject has long needed pruning, so as to separate much of the accumulated information which belongs properly to reference books, and reveal the underlying principles and the lines along which progress can be made. Few are better qualified to do this than the author: probably no one else could have produced in the process a book which, from cover to cover, is so readable. It is certain to be widely used by undergraduates, teachers and research workers, and to stimulate an interest which will lead to a more rapid advance in the correlation and interpretation of the facts of inorganic chemistry.

H. J. Emeléus

Foraminifera

Their Classification and Economic Use. By Joseph A. Cushman. Fourth edition, revised and enlarged, with an Illustrated Key to the Genera. Pp. viii+605 (86 plates). (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 55*s.* net.

A LEGACY to science of more than five hundred works on the Foraminifera has been left by the late Dr. J. A. Cushman, and, of these, there is little doubt that "Foraminifera: their Classification and Economic Use" (fourth edition) is of most general value both to the student, the research worker and the petroleum micropalæontologist. Each edition, as it appeared, was regarded as the main standby of modern knowledge of the genera of Foraminifera, and, although Cushman's division of them into families and natural groups is not necessarily acceptable to all, at least he has adhered to a constant main grouping throughout successive editions and, indeed, in all his works.

About 750 genera are defined and figured in the new edition and many recently described have been incorporated. It is good to see among his inclusions the genus *Fabiana* Silvestri, which was originally described as an Eocene coral. It is a pity that *Nummulostegina*, a Carboniferous genus, should have been defined and figured twice: once under the Fusulinidæ—the contribution on this family being made by Dr. Carl O. Dunbar—and again under the Camerinidæ [=Nummulitidæ]. Dr. Cushman and Dr. Dunbar would have done well to have conferred on this matter.

Many points of taxonomic interest could be debated; but it is easier to criticize than to construct, and in all fairness it is no exaggeration to say that Dr. Cushman's book is the most comprehensive, up-to-date text-book on the Foraminifera, and it marks the climax of the author's distinguished career.

C. D. Ovey

Wildfowling

By James Andrews, T. Clifford Bland, Robert Blockley, Robin Farmiloe, Robin Harrison, John Inge, Christopher Lee-Elliott, Alastair McArthur, Douglas Service and Michael Shephard. (Lonsdale Library of Sports, Games and Pastimes, Vol. 29.) Pp. 352+49 plates. (London: Seeley, Service and Co., Ltd., n.d.) 25*s.* net.

VOLUME twenty-nine of the Lonsdale Library is devoted to "Wildfowling", a team of ten writers having collaborated to produce it, each dealing with a section of which he has special knowledge. For example, Robert Blockley writes of geese, ducks, waders and so on, in short, the birds commonly spoken of as waterfowl, from the ornithological point of view, giving a brief description of the appearance, distribution, habitat, habits and food of each species; while T. Clifford Bland deals with shoulder guns and punt guns. Then Christopher Lee-Elliott gives us a note on the legal aspect of wildfowling; and John Inge writes at length on the practice of the sport, giving the beginner and those who are not beginners alike much useful information and helpful advice. There are also chapters on punts and punting by Douglas Service, Michael Shephard following with five chapters on "Inland Marsh Shooting". We then come to chapters on "Decoy Ponds" by Robin Farmiloe; on "Wildfowling on a Norfolk Estuary" by Robin Harrison; the "Hawking of Wildfowl" by Alastair McArthur; and lastly one on "First Aid and Shooting Accidents" by James Andrews. A glossary of wildfowl terms and a comprehensive index wind up the volume.

Where so much pains have been taken, where so wide a field has been covered and so much helpful information supplied, it seems a pity a little time was not devoted to the revision of details, for example, in the glossary we read "marram grass: see Zostera marina"! And surely the term "eyass" is and was used by falconers to denote a young hawk and not merely "fledglings captured by the setting of a snare"?

Frances Pitt

Britain's Beasts of Prey

By W. Kay Robinson. Pp. 128. (London: Latimer House, Ltd., 1949.) 7*s.* 6*d.* net.

THIS very readable book relates many little-known facts about British mammals that are threatened with extinction, together with claims for and against hunting them. The author quotes many fascinating stories about those disappearing species, the wild cat, pine marten and polecat, written in the pleasantly informative style with which followers of his very popular newspaper articles are familiar. He presents a strong argument in favour of that much-persecuted animal, the otter, proving that on streams where it is protected the fishing is improved, and condemning the senseless killing of one of the most useful wild animals in Great Britain.

Oliver G. Pike

Gmelins Handbuch der anorganischen Chemie

Achte völlig neu bearbeitete Auflage. System-Nummer 10: Selen. Teil B: Die Verbindungen des Selens. Pp. xxi+vii+195. (Clausthal-Zellerfeld: Gmelin-Verlag G.m.b.H., 1949.) n.p.

THE reappearance of this famous work is a welcome event. No other book can be compared with it in its field, and the standard of the new parts is as high as that of previous volumes. This particular part deals with the compounds of selenium with hydrogen, oxygen, nitrogen, halogens and sulphur. By reason of the scheme of arrangement, selenites and selenates must be looked for in other volumes dealing with the metals. The mode of treatment takes full account of the physics and physical chemistry of the substances. The copy sent for review was much disfigured by excessive rubber-stamping.

J. R. P.

Ions, Electrons and Ionizing Radiations

By Prof. James Arnold Crowther. Eighth edition. Pp. ix+322+7 plates. (London: Edward Arnold and Co., 1949.) 21*s.* net.

SINCE 1919, when it first appeared, this book has served many generations of students as an introduction to the major treatises on atomic physics. The earlier editions were noteworthy for the emphasis given to the pioneer work of Rutherford, Thomson, Townsend, and the others who laid the foundations of the subject; and this invaluable feature has not been sacrificed in the eighth edition, which carries the account of the main lines of progress up to the present time. The problem of selection for each successive edition must have become more and more difficult as the subject developed. It is sad to relate that, by the recent death of Prof. J. A. Crowther (see *Nature*, May 13, p. 250), this edition marks the last to be revised at his hands, for in it the author's judgment has been as happily exercised as ever.

G. R. Noakes

TRANSPLANTATION OF NUCLEI FROM CELL TO CELL

By Dr. I. J. LORCH and Prof. J. F. DANIELLI

Chester Beatty Research Institute, Royal Cancer Hospital, and the Department of Zoology, King's College, London, W.C.2

WHILE it is generally agreed that most of the factors so far studied which determine the character of an organism are part of, or attached to, chromosomes, in the last decade or so a considerable body of evidence has come to light showing that some of these factors are not directly associated with the chromosomes. Much of this evidence has been reviewed recently by Mather[1] and by Caspari[2]. One of the main experimental methods available for studying these factors is the use of mating.

In the field of differentiation, opinion has developed rather differently, inclining strongly to the view that the differences between the differentiated cell types of the same organism are produced by changes in the cytoplasm, and are maintained by the cytoplasm. Thus, it is commonly supposed that, apart from the intrusion of such phenomena as polyploidy and polyteny, the nuclei of all the somatic cells and germ-line cells (but not the germ cells themselves) have an identical gene constitution. As techniques based on mating are not available for studying somatic cells, it is difficult to test this supposition. On the other hand, it is quite clear that the characters of differentiated cells are in part determined genetically; when an animal displays a mosaic character in a tissue which is normally homogeneous, the mosaic is commonly attributed to mutation during development. In some cases mutation can probably be observed in a single somatic cell[3]. It is thus recognized that mutation, even in a very late stage of development, may markedly affect the character of a differentiating cell. The importance of the nucleus at the earliest stages of differentiation is shown by the experiments of E. B. Harvey[4] on enucleated sea urchin eggs. Enucleated eggs, when artificially activated, divide to give a crude blastula of up to 250 cells, but will not show any sign of differentiation. Many facts also attest to the quantitative importance of the nuclear factors; the action of a gene on differentiation may vary according to the number of genes of a particular type in the chromosome structure. When these considerations are weighed, it is clear that there is inadequate evidence of the extent to which differentiation is initiated by, and maintained by, the nucleus and cytoplasm respectively.

The simplest way to obtain unequivocal evidence of the extent to which irreversible changes occur in nuclei and cytoplasm during differentiation would be to transplant nuclei and cytoplasm from one type of cell to another. This presents a number of technical difficulties. But that the procedure is not impossible is shown by the work of Commandon and de Fonbrune[5], who transplanted nuclei from cell to cell in *Amœba sphæronucleus*. Their procedure was to remove the nucleus from one individual by pushing the nucleus out of the cell with a blunt microdissection needle—this involved a very small loss of cytoplasm. Then a nucleus was transferred into the enucleated cytoplasm from a second nucleated cell. A very small transfer of cytoplasm must have occurred at the same time.

Our first experiments have been with *Amœba proteus* and *Amœba discoides*, stocks of which were kindly given to us by Sister Monica Taylor and Sister Carmela Hayes. Mass cultures were grown from single individuals. These two species are not so convenient for microdissection as is *A. sphæronucleus*, but have the advantage that mass cultures can readily be grown from single individuals under laboratory conditions, whereas according to de Fonbrune this is not so with *A. sphæronucleus*. We have made transfers of nuclei both between individuals of the same species (homotransfers) and individuals of different species (heterotransfers).

For convenience in reference, a symbolism has been used: thus $P_n \rightarrow D_c$ indicates transfer of a *proteus* nucleus to *discoides* cytoplasm. The general procedure was to remove a nucleus from an amœba and transfer a nucleus from a second cell within ten minutes, using the technique of Commandon and de Fonbrune. The animal was then placed in a watch glass containing a rich culture of *Chilomonas* in Chalkley's fluid. If the animal multiplied, the culture was transferred to a Petri dish when 50–100 cells were present, and to a large 'Pyrex' dish when the Petri dish was becoming crowded.

When an amœba is enucleated, the cytoplasm assumes the form of a sphere with numerous short blunt pseudopods. When transferred to a watch-glass some recovery takes place, and short periods of amœboid movement alternate with periods of quiescence and unco-ordinated cytoplasmic streaming. After some days, the cell again becomes rounded, with short pseudopodia, and rarely lives more than twenty days. When a nucleus is transferred successfully, normal appearance and ability to move may be recovered in a few seconds, though several hours may elapse before recovery is complete in the case of some animals. In the subsequent discussion, an animal which has undergone this change is referred to as 'reactivated'.

Type of transfer	Homotransfers		Heterotransfers	
	$P_n \rightarrow P_c$	$D_n \rightarrow D_c$	$D_n \rightarrow P_c$	$P_n \rightarrow D_c$
Number of transfers	55	52	60	61
Number of amœbæ reactivated	52	42	51	45
Number of amœbæ dividing at least once	37	38	22	3
Number of amœbæ giving mass cultures	34	37	0	1

The accompanying table gives a summary of the results obtained by nuclear transfer. With homotransfers, about 90 per cent of animals were reactivated. Of those reactivated, the great majority divided at least once. Of the animals which divided once, more than 90 per cent eventually produced mass cultures; that is, about 65 per cent of the nuclear transfers were completely successful.

With heterotransfers, about 80 per cent of animals were reactivated, and there was no great difference between homo- and hetero-transfers in this respect. With the transfer $D_n \rightarrow P_c$, only about 40 per cent of the reactivated animals divided once or more, and no mass cultures were obtained from sixty transfers.

With the transfer $P_n \rightarrow D_c$, only three out of sixty-one animals divided once or more, and only one of these gave a mass culture.

A. discoides and *A. proteus* differ in a number of particulars; so far we have studied the effect of nuclear transfer on two of these differences, namely, nuclear diameter, and form assumed when moving. After division, the nuclear volume is at a minimum, and growth of the nucleus occurs to roughly twice the volume after division, before further division occurs. Consequently, in order to obtain a significant figure for the nuclear diameter of a particular stock, it is necessary to make measurements on a number of individuals. The nuclei of the species we studied are not symmetrical, so the largest diameter was measured. For *A. proteus* the largest diameter of the nucleus of our stock was 41 ± 5 μ, and for *A. discoides* 33 ± 2·6 μ.

With the transfer $D_n \rightarrow P_c$, twelve nuclei were measured immediately before transfer, and again twenty-four hours later. The average of the initial diameters was 33 μ, which is the average for *A. discoides*. After twenty-four hours, the average diameter had increased to 39 μ: this is outside the range for *A. discoides* (33 ± 2·6 μ) and within the range of *A. proteus* (41 ± 5 μ).

With the transfers $P_n \rightarrow D_c$ which did not give a mass culture, thirteen measurements were made on ten individuals which were the progeny of two transfers, at various times (up to twenty-eight days) after transfer. Although the measurements showed that any individual nucleus grew, before dividing, the average diameter after transfer was 38 μ, that is, still within the *proteus* range, though on the low side, since the nuclei were more than 40 μ before transfer.

With the transfer $P_n \rightarrow D_c$ which gave a mass culture, numerous measurements of nuclear diameter were made, at fortnightly intervals. The average diameter was 33 ± 3·3 μ, which is practically identical with the value characteristic of the pure *discoides* line (33 ± 2·6 μ).

It must be emphasized that when a clone is derived from one individual of another clone, the average nuclear diameter of members of the new clone is not dependent upon the diameter of the nucleus of the individual amœba used to start the new clone. A clone of *A. proteus* grown from an amœba of nuclear diameter of 35 μ has the same average diameter as a clone grown from another individual which, when chosen from the same parent clone, had a diameter of 45 μ. Thus the variations which are observed after nuclear transfer cannot be attributed to variations in the size of the nucleus at the time of transfer.

From these measurements a marked tendency is evident for the nuclear diameter to be determined in part by the cytoplasm.

Studies of the form of moving amœbæ were made by tracing the outline of individuals, at intervals, using a camera lucida. The outline of *A. discoides* is characteristically more serrated than is that of *A. proteus*, and unlabelled drawings are readily sorted into the two species by inspection of the outline. When the outlines of individuals from the mass culture resulting from the transfer $P_n \rightarrow D_c$ were examined, the outlines fell between the *discoides* and *proteus* forms. When different observers were given a mixed collection of outlines of *proteus*, *discoides* and $P_n \rightarrow D_c$, some classified the heterotransfer as *discoides* or *proteus*, and other observers preferred to group the heterotransfer outlines in a third group.

From this result it appears that the form assumed by an amœba in movement is in part determined by the nucleus, and in part by the cytoplasm.

Our results show that when nuclei are transferred from one amœba to another of the same species, the transfer can be successful in a high proportion of cases. Activation of the cytoplasm, division, and formation of mass cultures occur readily.

When nuclei are transferred from one species to another, activation occurs readily. But nuclear and cell division occur much less readily than with homotransfers, and formation of a mass culture is rare. Nevertheless, nuclei of either species can grow, divide, and cause cell division, after transfer to the cytoplasm of another species.

Studies of nuclear diameter and of form when moving both suggest that the cytoplasm has an important influence. The culture $P_n \rightarrow D_c$ has now been maintained for more than a year, but still shows no sign of closer approximation to the *proteus* type. Much further work is needed, and more characters must be studied, before it will be wise to base any generalizations on these experiments.

We are deeply indebted to: Prof. A. Haddow, Dr. J. A. Kitching, Prof. H. G. Callan, Sister Monica Taylor and Sister Carmela Hayes, for help and advice, and to the British Empire Cancer Campaign for financial support.

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FRICTION*

By Dr. F. P. BOWDEN, F.R.S.

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If we slide one solid body over another, there is a resistance to the motion which we call friction. What is the cause of this, and what is really happening at the interface between the solids during sliding? It is usually considered that friction is a nuisance, and from earliest times man has made ingenious attempts to eliminate or to diminish it to as small a value as possible. It is not so much the work we have to do in overcoming friction—the power loss—which is important, although this can be considerable. In a modern motor-car, for example, about 20 per cent of the power is wasted in overcoming friction. In an aeroplane piston engine it is about 9 per cent, and in a modern turbo jet engine it is about 1½–2 per cent. The real trouble is the damage that is done by friction—the wear or seizure of some vital part of the machine. It is this factor, perhaps more than any other, which limits the design and which shortens the effective working life of, say, an aero-engine or other complex machine. Nevertheless, the credit side is considerable: if the coefficient of friction were much less than it is, walking would be impossible and we should have to use cog wheels or perhaps some system of suction pads like an octopus to get about at all. Conversely, if it were much higher than it is, we should just stick fast wherever we were put.

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* From a Friday Evening Discourse at the Royal Institution, delivered on May 19.

There are two basic laws of friction. The first of them says that the frictional resistance is independent of the area of the sliding surfaces, and the second that it is proportional to the load between them. It would seem that Leonardo da Vinci (1452–1519), with his astonishing practical genius and insight, was clear about them, for he writes: "The friction made by the same weight will be of equal resistance at the beginning of the movement although the contact may be of different breadths or lengths", and "Friction produces double the amount of effort if the weight be doubled". The rediscovery of these laws by the French engineer Amontons in 1699 was, however, received with some surprise and scepticism by the Royal Academy of Sciences in Paris.

Since the friction is proportional to the load, we may define the coefficient of friction as the ratio

$$\frac{\text{the frictional force}}{\text{the applied load}}.$$

For a brick sliding on wood, the coefficient of friction is about 0·5; for clean metals in air, it is about 0·5 to 1; for boundary lubricated metals, about 0·1.

Amontons's observations were verified by Coulomb in 1781, who made a clear distinction between static friction, the force required to start sliding, and kinetic friction, the force required to maintain it. He showed that kinetic friction could be appreciably lower than static friction and made the observation, which is sometimes quoted as a third law, that the kinetic friction is nearly independent of the speed of sliding. Coulomb considered the possibility that friction might be due to molecular adhesion between the surfaces, but rejected it on the grounds that if this were so the friction should be proportional to the area of the sliding bodies, whereas it was found to be independent of it. He concluded that the friction was due to the inter-locking of the surface asperities and represented, in the main, the work of lifting the load over the summits of these asperities. He had some reservations about this theory, but he hesitated to speculate further because, as he pointed out, the Royal Academy of Sciences only wanted useful results, not theories. I hope to show that that first view is, in fact, more correct, and that friction is due in a large measure to adhesion between the surfaces.

In recent times experimental investigations in friction, particularly of static friction of solids lubricated with very thin films of hydrocarbon, were made by Sir William Hardy. In particular, Hardy showed the important part played by a single molecular layer of lubricant (the boundary layer). His own experiments were elegant and simple, and he emphasized the necessity for applying modern physical and chemical concepts and methods to the study of these surface phenomena. It is perhaps Hardy's work more than any other that stimulated a modern approach to the subject.

Area of Contact between Solids

Now the first question we may ask is this: What is the real area of contact between solids?

It is a very difficult matter to prepare surfaces which are really flat; even on carefully polished surfaces, hills and valleys are present which are very large in comparison with the size of a molecule. If two solids are placed in contact, the upper surface will be supported on the summits of the irregularities and large areas of the surface will be separated by a distance which is great compared with the molecular range of action. Even with modern techniques of cleaning and polishing, it is still a difficult matter to prepare surfaces of appreciable size which are flat to within 100–1,000 angstroms. Most of the surfaces used in engineering practice have surface irregularities which are much greater than this. Our first point of investigation was therefore into the shape and size of these irregularities, in an attempt to determine what is the real area of contact between solids. In addition to the use of a stylus instrument such as the Talysurf, various methods are being employed for investigating this problem. The first method consists simply of cutting a section through the solid and looking at the surface irregularities under a microscope. A simple technique is, however, used to increase the sensitivity of the method. If, instead of cutting the section at right angles to the surface, it is cut at an angle of a few degrees, the effect is to magnify the irregularities in a vertical direction by a factor of ten or so, leaving the horizontal magnification unchanged (see Fig. 1).

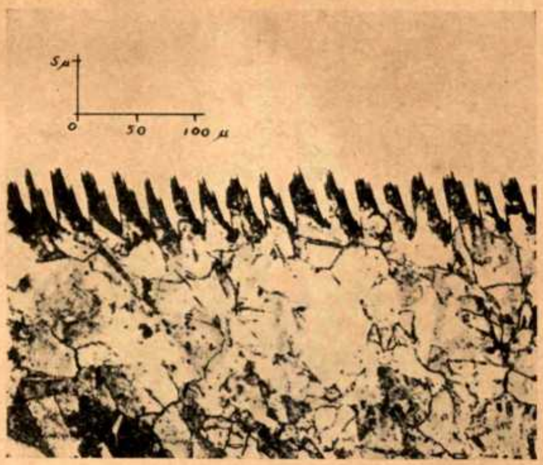


Fig. 1. Oblique section of finely turned copper surface. Vertical magnification × 1,800, horizontal magnification × 175. Height of surface irregularities about 50,000 angstroms

The second method is the use of the electron microscope. This is, for certain purposes, a much more powerful tool and can resolve detail down to about 20 angstroms. The electron microscope shows that the smoothest surface we have been able to prepare by electrolytic polishing still has hills on it which may be several hundred angstroms high.

A third method depends on interference of waves of light. With the ordinary two-beam interference method, the light and dark interference bands are comparatively broad and diffuse. Tolansky has recently developed interference methods to a high degree of sensitivity by making the surfaces highly reflecting and using multiple reflexion. This has the effect of making the interference lines very sharp, so that very fine detail on the surfaces can be revealed. It is even possible to detect steps on the surface which are only two or three angstroms high, and an examination of cleaved crystals shows that they have steps on them some hundreds or even thousands of angstroms in height.

It is clear from all these measurements that the real area of contact between solids will be very small. Putting two solids together is rather like turning Switzerland upside down and standing it on Austria. Some knowledge of the area in contact is essential for our purpose, and its determination is a matter of

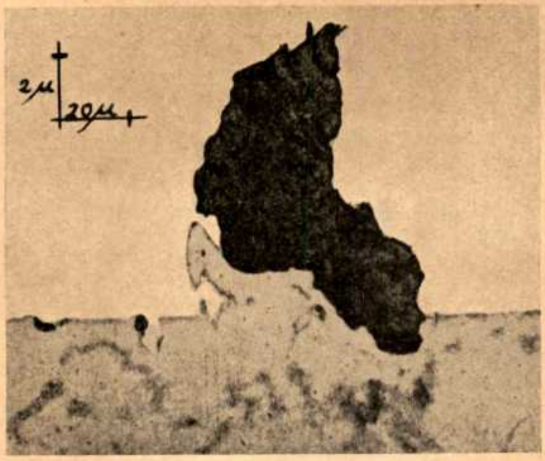


Fig. 2. Oblique section of steel surface after copper slider has passed over it once. Vertical magnification × 4,200, horizontal magnification × 410. Copper fragment (dark colour) is adhering to steel. Note how it has pulled the steel up above the surface

some experimental difficulty. Fortunately, with metals an approximate estimate of it can be made by measuring the electrical resistance across the surface of the metals when they are in contact. If the metals touch at a number of points, the electric current will be carried across at these points, and by measuring the electrical resistance it is possible to form an estimate of their size. The results show that the real area of contact is indeed very small; it varies with the load, but for flat steel surfaces it may be less than one ten-thousandth of the apparent area. The experiments are also interesting in that *they show that the real area of contact is almost independent of the size of the surfaces*. It is also very little influenced by the shape and degree of roughness of the surfaces. It depends mainly on the load which is applied to them, and is, in fact, *directly proportional to the load*. The general behaviour is consistent with the view that the surfaces are held apart by small irregularities. This means that, even with lightly loaded surfaces, the local pressure at these small points of contact is very high, and may be sufficiently great to cause steel to flow plastically. Although the stresses will cause elastic deformation of the metal in the vicinity of the points of contact, the experiments suggest that the summits of irregularities on which the bodies are supported flow plastically, and are crushed down until their cross-section is sufficient to enable them to support the applied load. These experiments offer an explanation of the first 'law': since the real area of contact between the solids is independent of the actual size of the surfaces, we should also expect that the friction would be independent of their actual size. Also, since the real area of contact is proportional to the applied load, it offers an explanation of the second 'law'.

The fact that the real area of contact is so small has important practical implications. Even when loads of only a few hundred grams are applied to the surfaces, the local *pressure* between them may be sufficiently great to cause the flow of metal. When large flat surfaces are used, it does not mean that the real pressure is much less, but merely that the points of contact are more widely distributed. This intense pressure will cause an adhesion or 'pressure welding' at the tiny points of contact and so produce small metallic junctions between the surfaces. The reality of these localized adhesions may be shown in a number of ways. If, for example, we slide a piece of copper over steel, and then examine the surface by the taper section method, we may detect fragments of copper which are adhering to the steel (Fig. 2). Another sensitive method of doing this is to use, as a slider, an artificially radioactive metal. If this localized adhesion takes place, small fragments of the radioactive metal will be welded on to the other surface, and we may detect their presence either by a Geiger counter or by an auto-photographic method (Fig. 3).

There is strong evidence that the friction of metals is due, in a large measure, to these localized adhesions and represents the force necessary to shear these small junctions.

Friction and Adhesion

If this localized welding occurs between the metals when they are placed in contact under an applied load, we might expect that when the load is removed the surfaces should continue to adhere, and that an appreciable *normal* force will be required to separate them. If, however, we perform this experiment with reasonably hard metals such as steel and copper, we find no evidence for any such adhesion. Why is this? It is suggested that the explanation is a simple one. Although the metal is deformed plastically at the points of contact, there will be elastic deformation in the bulk of the metal near by. When the load is removed, these elastic stresses will be released and the resulting displacement will break any junctions that may have been formed. This view is confirmed by experiments with soft metals, such as indium and lead, where the released elastic stresses are very much less. In fact, we find with these soft metals that the normal force required to separate the surfaces is very nearly the same as the tangential force required to slide them; that is to say, the coefficient of adhesion and the coefficient of friction are approximately the same. The effect of a lubricant film, even of a monolayer, will reduce the adhesion to a very small value. We have therefore a close correlation between friction and adhesion.

General Effect of Surface Films

There is another observation of Leonardo da Vinci's which is very relevant to our purpose. He

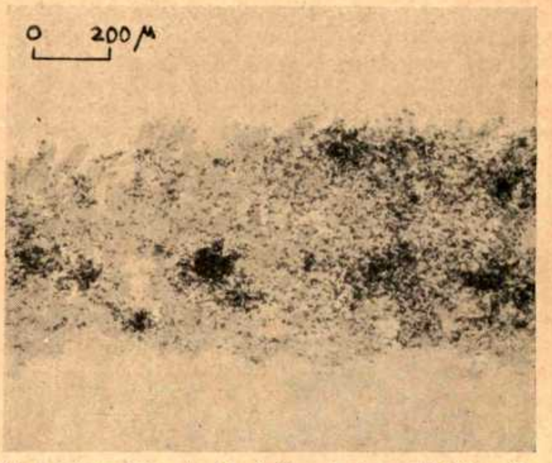


Fig. 3. Autoradiograph of track formed when artificially radioactive copper is slid over lubricated copper surface once. Magnification × 50. Dark spots show where copper from slider is adhering to lower surface. Surface concentration approximately 10^{-8} gm. per mm.^{2}

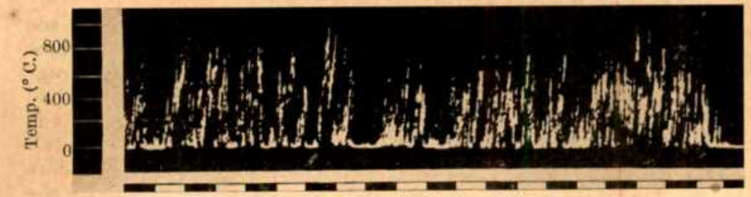


Fig. 4. Surface temperature developed with a constantan slider on a finely ground steel surface. Load 500 gm. Speed of sliding 300 cm. per sec. The temperature flashes may be as high as 1,000° C. and are of very short duration

writes: "All things and everything whatsoever, however thin it be, which is interposed in the middle between objects that rub together, lighten the difficulty of this friction". The experiments which we have described have been carried out on surfaces which have been very carefully cleaned. We know, however, that when metals are exposed to the air, their surfaces are covered by a thin film of oxide which is at least several molecular layers in thickness. It is very difficult to remove the last adsorbed layer, and we can only achieve it by heating the metal to a very high temperature in a vacuum. If we perform this experimentally, we find there is, indeed, a profound change in the friction.

If two pieces of metal are heated in a high vacuum, so that all surface films are driven off, and are then allowed to cool and placed in contact, it is found that immediate and complete seizure occurs. The coefficient of friction has no real meaning, but it may rise to 100 or more: it is necessary to prise the surfaces apart with a chisel and the contact has the bulk strength of the metal. It is only when we allow a trace of air, or other contaminant, to enter the apparatus that the friction falls to a reasonable level. This observation that the friction of naked solids is very high makes us realize how fortunate it is that in engineering practice, and, in fact, in many everyday affairs, metals and other surfaces are always contaminated even when we think we have cleaned them thoroughly. If it were not for this, we would find the world a very 'sticky' place to live in, and much of our machinery would come to a sudden and disastrous stop.

Surface Temperature of Sliding Solids

All these experiments are for surfaces which are moving very slowly. What happens if the sliding speed is appreciable ? One of the most important differences is that there will be a temperature rise at the surface.

The energy lost during sliding is dissipated mainly in the form of heat, and quite primitive calculations of the amount of heat liberated and of the rate at which it is conducted away suggest that the temperature rise of the surface layers may be high. If we endeavour to measure this by embedding thermometers in the solids near the surface, we find that the rise is very small, but this is mainly because we cannot get close enough to the surface. An obvious method is to use the surfaces themselves as a thermometer. We may make our sliding surfaces of two different metals, and use the rubbing contact itself as a thermocouple. A measurement of the electromotive force generated on sliding them provides a record of the surface temperature.

Such measurements confirm in a very striking way the existence of local high temperatures at the points of contact of the rubbing surfaces. As would be expected, the temperatures reached depend upon the load, the speed of sliding and the heat conductivity of the metals. Also the temperatures fluctuate very rapidly during sliding, and it is necessary to use an instrument of high frequency, such as a cathode ray oscillograph or high-frequency galvanometer, in order to record them. It is found that, with the lower melting metals, we readily reach their melting point, and the temperature does not rise above this.

With metals of high melting points, however, temperatures of the order of 500–1,000° C. are easily reached. These temperatures are confined to the very thin surface layer, and the mass of the metal appears to be quite cool. These very high temperature flashes of 1,000° C. may last only for a few ten-thousandths of a second (Fig. 4).

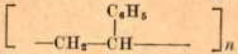
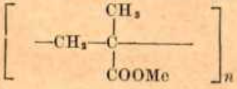
If we slide non-metals such as wood or glass or diamond, which are bad thermal conductors, we should expect the temperature rise to be still higher. We cannot, of course, use this thermo-electric method to measure the temperature. We may, however, use other means, one of which is a visual method. If polished surfaces of glass or quartz are used, and the apparatus so arranged that a clear image of the rubbing surfaces can be seen, it is found that, if the sliding is carried out in the dark, a number of tiny stars of light appear at the interface between the rubbing surfaces. The points of light are reddish in colour at low speeds, and become whiter and brighter as the speed or the load is increased. It is clear that they correspond to small hot spots on the surface, and their position and distribution over the surface change from instant to instant as the high points in intimate contact move or wear away, and new points come into contact. These hot spots can also be photographed in a very simple way: if a photographic plate is placed on a turntable with the glass side upward and allowed to rotate with a metal slider resting on it, the luminous hot spots developed at the points of rubbing contact will photograph themselves on the emulsion. An alternative, and a valuable method, is to use a lead sulphide cell which is sensitive to flashes of infra-red radiation. With this we have been able to measure the rapid rise and fall in temperature of a single hot spot.

The main point to be emphasized here is how easily local high temperatures are developed. For example, with two non-conductors sliding together, or even with a metal sliding on a non-conductor, the temperature at the local points of contact may exceed 500° C., that is, red hot spots can be formed, although the speed of sliding is only one or two feet per second. These local hot spots are important in a number of physical processes associated with the rubbing of solids. They are, for example, very important in polishing, and there is strong evidence that the formation of the polished, or Beilby, layer on metals and other solids when they are rubbed is due to a localized melting or high-temperature softening of the solid at the points of rubbing contact. They also play an important part in skiing: the low friction of sliding on ice and snow is due in a large measure to a localized surface melting.

Frictional Properties of Plastics

We may gain further insight into the mechanism of friction by considering the behaviour of a group of structurally related plastics (Table 1).

TABLE 1

Polymer	Chemical formula	Coefficient of friction
'Teflon'	$\left[-CF_2-CF_2-\right]_n$	0·04
Polyethylene	$\left[-CH_2-CH_2-\right]_n$	0·1
Polystyrene	 $\left[-CH_2-\overset{C_6H_5}{\overset{\mid}{C}H}-\right]_n$	0·5
'Perspex'	 $\left[-CH_2-\underset{COOMe}{\overset{CH_3}{C}}-\right]_n$	0·8

It will be seen that the friction of the plastics 'Perspex' and polystyrene, which have branching side-chains, is high. Putting it crudely, we may say that the branching side-chains interlock and get in the way, and we cannot easily slide one sheet of molecules over the other. Polyethylene, which is a simple long-chain compound, gives a comparatively low friction, $\mu = 0{\cdot}1$, and sliding can occur more easily. Now let us consider a reasonably new plastic, namely, 'Teflon'. In this, the hydrogen atoms are replaced by fluorine. The fluorine atom is large and has an effective negative charge, so that it will screen the positive charge on the carbon atoms. Slip should occur easily between these negative sheets of fluorine and the friction should be low; the coefficient of friction is indeed very low, $\mu = 0{\cdot}04$, which is comparable with that of ice. It has remarkable frictional properties and even at 300° C. the friction is still very low. It will undoubtedly prove a valuable material. It has, however, certain disadvantages. It is a non-conductor of heat and has a high coefficient of thermal expansion. If we use it as a bearing, it may get hot, expand and stick. We have therefore tried the experiment of incorporating it in a porous metal. We take, say, sintered copper which has a number of fine pores in it and impregnate the surface layers with 'Teflon' (Fig. 5). In this way we have a material which possesses the mechanical properties and thermal conductivity of sintered copper, but, since the surface is always covered with a thin film of 'Teflon', it has the frictional properties of 'Teflon' (Table 2).

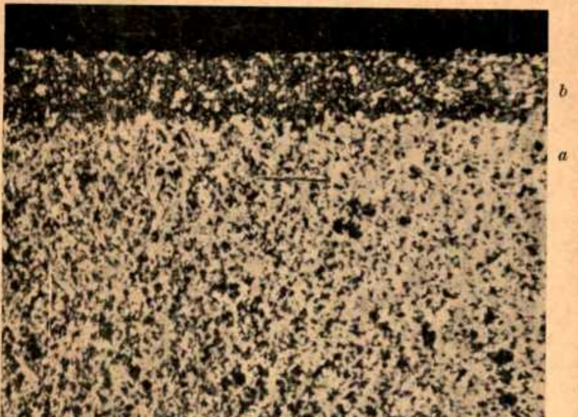


Fig. 5. Section of sintered copper impregnated to a depth of about 1 mm. with 'Teflon'. (*a*) Sintered copper, (*b*) impregnated surface layer. Magnification × 10

TABLE 2

Temperature	Coefficient of friction	
	Copper	Copper impregnated with 'Teflon'
15° C.	about 1·0	0·05
100° C.	,, ,,	0·05
200° C.	,, ,,	0·05
250° C.	,, ,,	0·05

This value for the coefficient of friction of 0·05 is lower than the boundary friction usually obtained even with very good lubricants. Moreover, the act of sliding does not remove the film, but merely feeds it on to the surface. Such a material should prove a useful bearing or anti-friction material which can be used without any lubricant and which will function at quite high temperatures.

There has been some tendency in the past for us to accept the surface which the engineer gives us, and then try to make it work and to lubricate it. There is something to be said for the alternative of designing a surface which has the right frictional properties and then giving it to the engineer to use.

RESEARCH LABORATORIES OF THE BRITISH ELECTRICITY AUTHORITY

By DR. J. S. FORREST
Director

THE power stations of the British Electricity Authority have a total capacity of 10 million kW. and generate about 46,000 million kWh. a year; it is evident that there is great scope for research on the operational problems of an industry of this magnitude.

The first opportunity for research on a national basis occurred in the early years of operation of the National Grid system, when it became apparent that a central laboratory was necessary to investigate the high-voltage transmission problems which were then being encountered for the first time in Great Britain. Accordingly, the Central Electricity Board established laboratories at Croydon in 1932–34, and in the following years made plans to build more comprehensive laboratories at Leatherhead, equipped to investigate the diverse electrical and mechanical, physical and chemical, problems which arise in the operation of an extensive transmission system. Owing to the difficulties of the Second World War and the immediate post-war years, however, it was not possible for the Board to start work on the Leatherhead project. With the coming of nationalization of the supply industry (Electricity Act, 1947), the laboratories of the Board became in April 1948 the central laboratories of the British Electricity Authority. Moreover, the 1947 Electricity Act placed considerable emphasis on research, so that the Authority was able to proceed immediately with the construction of the research laboratories at Randall's Farm Lane, Kingston Road, Leatherhead, Surrey. The new building was started in June 1948, and was formally opened this year on July 15 by the Rt. Hon. Lord Citrine, chairman of the Authority.

It is the aim of the Laboratories to contribute to the solution of any of the manifold problems which may arise in the electricity supply industry. Detailed investigations cannot, of course, be made in all parts of such a wide field, and close co-operation is therefore maintained with other national bodies, research associations, manufacturers, universities, engineering institutions, professional institutes and scientific societies.

The nature of the scientific work of the Laboratories may best be indicated by summarizing some of the investigations which have been undertaken or are now in progress. When 132-kV. overhead lines and substations were first put into operation in industrial areas, difficulties were experienced due to the flashover of insulators in fog, and research was initiated with a view to solving this problem. The immediate object of this work was to devise a method of measuring the performance of insulators operating in these conditions ; the best available type could then be employed, and improved designs could be developed. This work next led to a study of the electrical properties of aqueous films on porcelain surfaces and then to the elucidation of the mechanism of insulator flashover in humid and polluted atmospheres. Furthermore, it was found that the reliability and efficiency of high-voltage insulators could be increased if the voltage distribution were controlled in such a way as to prevent excessive voltage gradients or spark discharges. One method of achieving this is to glaze the porcelain insulators with a glaze having the required resistance, and this led to the development by an English manufacturer of a semi-conducting ceramic glaze. Semi-conducting glaze consists essentially of a mixture of metallic oxides incorporated in a glassy matrix ; this material has an interesting structure, and work is at present in progress on its electrical characteristics and on the contact phenomena between the glaze and a metal or cement electrode.

Certain aspects of insulating liquids are also being investigated. For example, a D.C. conductivity test has been devised for controlling the condition of hydrocarbon oils used in transformers and switchgear. In this connexion, the mechanism of conductivity in insulating oil containing very small quantities of free water is being studied. Experimental investigations are also being made on the oxidation of oil and on the interfacial tension at an oil-water interface.

An important programme of research on high-voltage transmission has been started recently. An experimental transmission line, 800 yards long, has been built for this work, and is at present being operated at 250–300 kV. Measurements are being made of the power loss due to corona discharge and insulator leakage in various weather conditions. The intensity of the radio interfering field from this line is also being measured, and comparisons are being made of the signal/noise ratio for amplitude-modulation and frequency-modulation transmissions. Interference with television reception is being studied, and it has been found that good reception can be obtained with the television aerial only ten yards from the line conductors.

About forty per cent of the breakdowns on the overhead lines of the National Grid system are due to lightning, and much attention has therefore been directed to methods of improving the performance of power systems when subjected to high surge voltages. Three lines of investigation are at present being followed : in the first place, the electric strength of insulating materials and power system plant is being studied under impulse conditions—the new 1,400-kV. surge generator at Leatherhead will be of assistance in obtaining experimental data in this wide field ; secondly, radio methods are being used to give the control engineers objective information about the occurrence of thunderstorms in the areas under their control ; and finally, the records of system breakdowns due to lightning are being examined statistically. It is noteworthy that a recent analysis of breakdown records for fourteen years gives a reliable picture of the seasonal and diurnal variations in thunderstorm severity and of the fluctuations from year to year.

About twenty thousand miles of steel-cored aluminium conductor is in use on the Grid lines, and development work is continually in progress on methods of jointing and protection against corrosion in industrial and coastal atmospheres. Samples of conductor from various parts of Great Britain are examined, and an interesting result of this work is that pure aluminium has been found to corrode progressively—the commonly accepted view that a protective layer is formed which prevents further attack is erroneous.

Other transmission problems which are being studied are conductor vibration, earthing, de-ionization of arcs, radio and inductive interference, harmonics, and the measurement of noise from transformers and air-blast switchgear.

As the new Laboratories have grown from the transmission background of the Central Electricity Board, it is only to be expected that most of the work should be devoted to electric power transmission. The scope of the work is now being extended to cover generation and distribution more adequately. For example, investigations have been made to develop methods of reducing the precipitation of moisture from generating-plant water-cooling towers. This apparently mundane problem has led to interesting experiments with a model cooling tower and to a study of the physical and meteorological phenomena relating to water droplets. The results obtained may then suggest possible ways of improving cooling-tower efficiency. Thus, as frequently happens, an operational trouble leads to testing and development, then to 'pure' research, and finally, through 'applied' research, back to normal practice.

OBITUARY

Dr. G. A. Waterhouse

GUSTAVUS ATHOL WATERHOUSE, who died on July 29, took a prominent part in the development of natural history in New South Wales over a period of more than forty years. He was born at Waverley, Sydney, on May 21, 1877, and was educated at Sydney Grammar School and the University of Sydney. He graduated B.Sc. in 1899 and B.E. in 1900. After graduation he was appointed to the assay staff at the Sydney branch of the Royal Mint and remained there until the Mint was closed in 1926, when he retired. In 1924 he obtained the degree of D.Sc. at the University of Sydney for his work on the hybridization of butterflies.

Waterhouse made important contributions to science in Australia in two ways : first, by his researches on Australian butterflies and, secondly, by his activities in connexion with the advancement and administration of scientific societies and institutions. His collection of butterflies which ultimately became the finest existing collection of Australian species was commenced in 1893 while he was still at school. It is now preserved in the Australian Museum, to which he presented it about fifteen years ago.

Waterhouse took an active part in the Australian societies interested in science in general and natural history in particular, and most of them he served in an executive capacity at some time. The Royal Entomological Society of London conferred on him the unusual distinction of Honorary Life Fellowship. He was honorary entomologist of the Australian Museum from 1919; an elective trustee from 1926 until his resignation in 1947 on account of ill-health; and president of the Board of Trustees in 1930.

For any ordinary man it might be expected that an absorbing interest in Lepidoptera and intense activity in scientific societies would occupy all the leisure time available. But Waterhouse was remarkably active, both physically and mentally, and always had some interests in addition to those mentioned. About 1900 he was interested in the distribution of basic volcanic dykes in the Triassic Hawkesbury Sandstone Series in the Sydney district; for many years he collected Mollusca, of which his mother presented a fine collection to the Australian Museum; and he was a keen philatelist. He is survived by his widow, two sons and two daughters; one son was killed on active service in New Guinea during the Second World War. A. B. WALKOM

NEWS and VIEWS

Civil Engineering at Liverpool:

Prof. R. G. Batson

PROF. R. G. BATSON retires at the end of September from the John William Hughes chair of civil engineering in the University of Liverpool. After leaving King's College, London, he received practical training at Woolwich Arsenal. In 1908 he went to the National Physical Laboratory and was one of a team of five members in the Engineering Department at that time. For some years he carried out research of a mechanical engineering nature, but later became a principal scientific officer on road research and was in charge of the Road Research Board. He was appointed to the chair of civil engineering in the University of Liverpool in 1936, and since that time he has directed the teaching of that branch of engineering in an energetic, enterprising and sympathetic manner. He has introduced new courses of lectures, and his success may be gauged by the readiness with which his students secure satisfactory appointments. During his tenure of the chair, Prof. Batson has been dean of the faculty of engineering for a continuous period of ten years. The holder of a number of awards for original papers, Prof. Batson is also the joint author of a well-known book on "Mechanical Testing" and has recently published a book on "Roads".

Dr. J. B. B. Owen

DR. J. B. B. OWEN, who succeeds Prof. R. G. Batson on October 1 at Liverpool, is thirty-nine years of age and obtained a first-class honours degree in civil engineering in 1931 at University College, Cardiff. He was awarded the Meyricke Scholarship to Jesus College, Oxford, in 1931, where he studied for two years in the Engineering Laboratory and graduated as B.Sc. (Oxford) for research on "Problems of Stress Distribution in Frameworks". He obtained his doctorate (D.Sc.) at Oxford this year. After leaving Oxford in 1933, Dr. Owen was engineering scientific assistant for two years at the British Cotton Industry Research Association, where he was employed on the development of machinery for opening and cleaning cotton, and afterwards for one year in the Design and Stress Office of Messrs. A. V. Roe, Manchester, on the development of autogyros and aeroplanes. Dr. Owen spent twelve years, 1936–48, on the scientific staff of the Royal Aircraft Establishment, where his main duties consisted of research on aircraft structures and instruction of staff investigating aircraft accidents, airworthiness, and full-scale structural research in flight and landing. Most of Dr. Owen's work while at the Royal Aircraft Establishment has been published as *R.A.E. Reports* or as *Reports and Memoranda* of the Aeronautical Research Committee.

American Geographical Society Awards

THE following awards have been announced by the American Geographical Society: Cullum Geographical Medal, to Dr. H. W. Ahlmann, professor of geography in the University of Stockholm, for inspiring "international cooperation in world-wide glacier study"; Charles P. Daly Medal, to Prof. L. Dudley Stamp, professor of social geography in the London School of Economics and Political Science, University of London, and adviser on rural land utilization to the Ministry of Agriculture, for "contributing much to the increase of food production in Britain and for a leading part in recent efforts at town and rural planning for optimum use of the land"; David Livingstone Centenary Medal, to Prof. R. L. Pendleton, principal soil technologist, Office of Foreign Agriculture, U.S. Department of Agriculture, "as one of the world's leading experts in soil survey and classification".

Air Conditioning and New Lighting at the National Gallery, London

AIR-CONDITIONING plant and modern artificial lighting have recently been installed by the Ministry of Works in a gallery of the National Gallery, Trafalgar Square, London, W.C.2, and the public was admitted on August 21. This installation puts the National Gallery among the most advanced of its kind in Europe. During the Second World War, when the national collections were stored in Manod Quarry in a constant air-conditioned atmosphere (see *Nature*, 151, 123; 1943), the absence of the fluctuations in relative humidity which normally occur in the London climate reduced damage to the pictures by 75 per cent (this damage is more marked for pictures painted on wood rather than canvas). The experience of the War years led to the Weaver Report in 1947, when it was urgently recommended that air-conditioning plant should be built for preserving the national treasures in an atmosphere of constant temperature and relative humidity. Since the air is cleaned by the new plant, the pictures do not need glass fronts to protect them from dirt, and this helps the lighting in that problems of reflexion are eliminated. As regards the lighting itself, the gallery has a ceiling of special glass which does not alter the colour of the daylight filtering through. The artificial illumination is made up of both fluorescent tube lighting and filament lamps, which together produce a natural light of 15–20 ft.-candles in intensity. The air-conditioning machinery, which cost £15,000 together with building costs of £25,000, is large enough to serve a number of other rooms, and it is hoped to equip other parts of the National Gallery with this system in the future. The plant provides a temperature of 65° F. with air at 68 per cent relative humidity throughout the year; extreme winter and summer air conditions of, respectively, 30° F. at 78 per cent humidity and 80° F. at 58 per cent humidity, have been allowed for. The air enters through ceiling ducts and leaves by grilles at floor level, and it is treated at the rate of six complete changes an hour.

Fertility and Sterility

Fertility and Sterility, of which the first number was published in January (1, No. 1; pp. 99; New York: Paul B. Hoeber, Inc., Publishers, 49 East 33rd Street, New York 16; 8 dollars or 9.50 dollars a year) is the official journal of the American Society for the Study of Sterility. The general purpose of this new publication is to assemble in one place accounts of original investigations, reports of clinical experiences, review articles and correspondence pertinent to the subject of infertility. The more immediate purpose is to assist clinicians in the treatment of human infertility. In the past, information required by the clinical investigator or practitioner was scattered in papers in a wide range of periodicals, and from this point of view the appearance of the new periodical will be of substantial value to those interested in the problems of fertility and sterility. The Editorial Board of the new journal consists of physicians, and the articles which appear in the three issues published up to now are confined mainly to medical aspects of fertility and sterility in man. It seems, however, and is very much to be hoped, that the Editorial Committee will encourage contributions from outside the medical circle, particularly from research workers concerned with the basic sciences of anatomy, biology, embryology, genetics, physiology and veterinary medicine, who at present lead in most major developments in the field of fertility and sterility. Provided that such enlightened editorial policy is introduced and maintained, there is little doubt about the successful future of *Fertility and Sterility*.

Universal Congress of Esperanto

THE thirty-fifth Universal Congress of Esperanto was held at the Sorbonne in Paris during August 5–12, when more than two thousand members of about thirty nationalities took part. The Science Section of the Congress welcomed the initiative of a number of Japanese men of science in commencing to publish their work in Esperanto and appealed to other men of science, particularly those using the less widely understood languages, to follow their example. The Section also undertook, in collaboration with the Universal Esperanto Association and the International Scientific Esperanto Association, to ask leading men of science to name the text-books and other works in their respective fields which it would be most profitable to translate into Esperanto. This decision followed from a proposal in similar terms recently made by Prof. Lavergne, of the Faculty of Law at the Sorbonne. The Section also resolved, in conjunction with the International Scientific Esperanto Association and the Academy of Esperanto, on measures to be taken further to develop and standardize Esperanto technical vocabularies.

Foot-and-Mouth Disease Research

THE work at the Foot-and-Mouth Disease Research Station has up to the present been conducted under the scientific direction of a committee appointed by the Minister of Agriculture, with the financial and administrative arrangements being made by the Ministry. The Station is now to join the group of research institutes being financed by a grant-aid from the Ministry of Agriculture and coming under the scientific supervision of the Agricultural Research Council. The new governing body is being constituted by the Minister of Agriculture and the Secretary of State for Scotland, in agreement with the Agricultural and Medical Research Councils. The membership of the governing body is as follows: Sir Alan Drury (*chairman*), Dr. C. H. Andrewes, Prof. S. P. Bedson, Mr. T. Dalling, Prof. R. E. Glover, Dr. J. Russell Greig, Prof. Wilson Smith and Prof. W. I. B. Beveridge.

Royal Society of Arts: 1951 Centenary Prize

THE Royal Society of Arts is offering a 1951 prize of a gold medal and a sum of £500 for the best proposal submitted on "A Means of Promoting the Production or the Economic Utilization of Food in Great Britain". The proposal may be quite general or may be concerned with any particular branch or aspect of food production. The Society has instituted this prize as a part of its celebrations of the centenary of the Great Exhibition of 1851, which it originated, and as a revival of the policy of offering prizes for inventions and other projects, which the Society employed in the early days of its existence. Entries, which may be submitted by British subjects, citizens of the Commonwealth and the Irish Republic, and foreigners permanently resident in the United Kingdom, must reach the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, by March 1, 1951.

Congress on Building Research, 1951

A COMPREHENSIVE congress on building research, to be held in London during September 11–20, 1951, will mark the rapid developments in building science made since the end of the Second World War, and has been arranged because of the great and growing interest shown in the subject in many countries. The congress is sponsored by the British professional institutions and learned societies interested in building science, and by government departments, with the support of representative industrial federations in Great Britain. The Department of Scientific and Industrial Research is providing the central organisation. Papers are being invited from research workers in many countries on a wide range of topics, and arrangements are being made to welcome to the congress a large number of visitors from overseas.

The purpose of the congress will be to review the progress made in research in relation to architecture, building and the associated branches of civil engineering, and a large number of topics will be discussed. The programme will be organised in three divisions, which will hold concurrent meetings; visits to buildings of interest and to civil engineering works, etc., will also be arranged. Further details can be obtained from the Organising Secretary, Building Research Congress 1951, Building Research Station, Bucknalls Lane, Garston, Watford, Herts.

Fresnel Diffraction Pattern and the Electron Microscope

Mr. M. E. Haine, of the Associated Electrical Industries Research Laboratory, Aldermaston, writes that his attention has recently been directed to the report on the "Conference on Electron Microscopy, Delft", published in *Nature* of September 17, 1949, p. 481. In the first column on p. 482 Mr. Haine is reported as suggesting the use of the Fresnel diffraction pattern from a half plane as a test object for the determination of resolution in the electron microscope. He wishes to say that, in fact, he went to some pains in his paper to point out the fallacy in such a test. In his suggestion for the use of a half plane as a test object, Mr. Haine declared that it is only suitable for conditions of incoherent illumination, and went on to explain the complications arising when any degree of coherence is introduced.

The Night Sky in September

New moon occurs on September 12d. 03h. 29m. u.t., and full moon on Sept. 26d. 04h. 21m. The following conjunctions with the moon take place: Sept. 10d. 20h., Venus 1° S.; Sept. 16d. 17h., Mars 3° N.; Sept. 23d. 13h., Jupiter 1° N. In addition to these conjunctions with the moon, the following other conjunctions occur: Sept. 9d. 04h., Venus with Regulus, Venus 0·7° N.; Sept. 24d. 03h., Mercury with Venus, Mercury 2·6° S.; and Sept. 29d. 22h., Venus with Saturn, Venus 0·6° S. Mercury is an evening star during the earlier part of the month, setting at 19h. on Sept. 1, but is too close to the sun to be observed. On Sept. 17 the planet is in inferior conjunction and at the end of the month rises 1½ hours before the sun. Venus is a morning star, the times of rising being 3h. 25m., 4h. 05m. and 4h. 55m. on Sept. 1, 15 and 30, respectively, and can be seen in the morning hours, stellar magnitude −3·3. Mars can be seen for a short period in the evening, setting at 20h. 35m., 20h. and 19h. 30m. at the beginning, middle and end of the month, respectively. Jupiter is visible throughout the night, setting in the morning hours at 4h. 30m. on Sept. 1, and 2h. 20m. on Sept. 30. Saturn, in conjunction with the sun on Sept. 16, is not favourably placed for observation until the end of the month, when it is a morning star, rising more than an hour before sunrise, and can then be seen for a short time in the eastern sky. Occultations of stars brighter than magnitude 6 are as follows: Sept. 30d. 20h. 31·1m., 27 Taur. *m.* (*D*); Sept. 30d. 21h. 26·3m., 27 Taur. *m.* (*R*); Sept. 30d. 21h. 26·7m., 28 Taur. (*R*). *R* and *D* refer to reappearance and disappearance, respectively, and the latitude of Greenwich is assumed. A total eclipse of the sun, invisible at Greenwich, occurs on Sept. 12. The central line runs from lat. 85° 10′ N., long. 66° 42′ E., to lat. 34° 23′ N., long. 154° 35′ E. The circumstances of the eclipse are:

Eclipse begins	Sept. 12d.	01h.	23·2m.
Central eclipse begins	12	02	50·1
Central eclipse ends	12	04	27·0
Eclipse ends	12	05	53·6

A total eclipse of the moon, partly visible at Greenwich, takes place on Sept. 26, the circumstances being:

Moon enters penumbra	Sept. 26d.	01h.	20·0m.
,, ,, umbra	26	02	31·5
Total eclipse begins	26	03	53·8
Middle of the eclipse	26	04	16·7
Total eclipse ends	26	04	39·6
Moon leaves umbra	26	06	01·9
,, ,, penumbra	26	07	13·5

Vernal equinox is on Sept. 23d. 15h.

Announcements

The College of Physicians of Philadelphia has awarded the Alvarenga Prize for 1950 to Dr. Ephraim Shorr, associate professor of medicine, Cornell University Medical College, for his outstanding work on the mechanism of shock. The Alvarenga Prize was established by the will of P. F. DaC. Alvarenga, of Lisbon, Portugal, an associate fellow of the College of Physicians of Philadelphia, to be awarded annually by the College on the anniversary of his death on July 14, 1883.

A conference on differential anthropology has been organised by the Société de Morpho-physiologie humaine and will be held at the Abbaye de Royaumont (near Paris) during September 11–16. The programme of the conference will be devoted to the study of the morphological, physiological and psychological aspects of the differentiation of individuals, and a number of participants from countries other than France will be contributing papers. Further details can be obtained from the secretary-general of the conference, Dr. P. Mabille, 34 rue Raynouard, Paris 16^{e}.

The Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About seven hundred pounds a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Application forms, obtainable from the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, should be submitted not later than November 1. Applications from Fellows of the Society will receive prior consideration.

The premises of the headquarters of the British Scientific Instrument Research Association, 17 Princes Gate, London, S.W.7, have been acquired by the Government of Ethiopia for its Legation and must be vacated by the end of August. Consequently, it has been decided to move the information department and the library of the Association immediately to the Association's laboratories at 'Sira', Southill, Elmstead Woods, Chislehurst, Kent. Temporary accommodation will be provided in an existing bungalow within the grounds of the laboratories; but it is hoped that a new building, for which plans have already been approved, will be erected and completed by the summer of 1951. The bungalow will then form an annexe to the library and will provide valuable storage space for many years to come. New headquarters in London for the director and administrative staff are being sought.

COINCIDENCES BETWEEN PROTONS AND GAMMA-RAYS IN (*d,p*) REACTIONS

By C. D. CURLING and J. O. NEWTON
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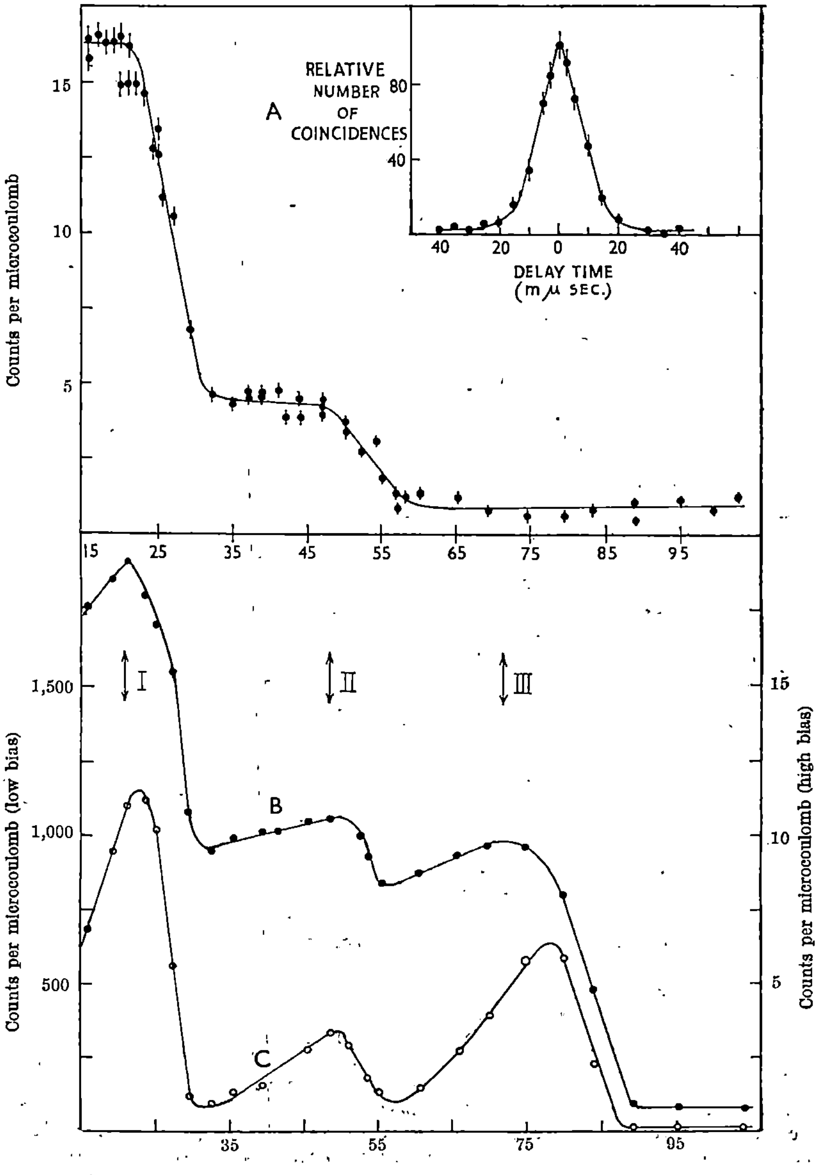
A COINCIDENCE circuit with a resolving time of 15 millimicroseconds has been employed to study the simultaneous emission of protons and gamma-rays from light nuclei under deuteron bombardment, using scintillation counters and photomultipliers (E.M.I. Type 5032). Naphthalene loaded with 1 per cent anthracene gave a high gamma-ray detection efficiency and a low sensitivity to neutrons. The protons were detected by a thin transparent layer of pure anthracene (~ 3 mgm. cm.$^{-2}$) obtained from the surface of a hot saturated solution in amyl acetate by cooling; the anthracene was first purified by four distillations with ethylene glycol.

Two coincidence units, each using a germanium diode and a shorted coaxial line to define the resolving time, were fed through 72-ohm coaxial lines from pulse limiters attached directly to each multiplier. The relative delay of the pulses could be altered by changing the lengths of these lines; a typical result is shown in Fig. *A*. One unit fed from the collectors of the multipliers, had zero relative delay and measured both real and random coincidences, while the other with a delay of 70 millimicroseconds was fed from the last dynodes and measured only the random counts. This simultaneous measurement of real and random counts avoided errors caused by fluctuations in the intensity of the deuteron beam.

The target was mounted in a thin copper wave-guide (2·7 cm. × 1·5 cm.) and the deuteron beam collimated by two molybdenum foil diaphragms of 1 cm. diameter. The detectors were mounted opposite each other at 90° to the beam. The solid angle in steradians subtended at the target by the proton detector was 0·48, and by the gamma-detector 1·9 and 0·68 during the proton-range and gamma-absorption measurements respectively.

The following results were obtained using a deuteron energy of 430 keV.

Li^6(*dp*)*Li*^{7}. A plot of the proton counts against absorber thickness gave an extrapolated range of 29·5 cm. for the long-range group, the two groups not being resolved. A similar plot of coincidence



Numbers-range curves for protons emitted in the bombardment of boron-10 by 430-keV. deuterons under identical geometrical conditions
A. Proton – gamma-ray coincidences.
B. Protons at low bias.
C. Protons at high bias.
The real-to-random ratio at I = 4·2; at II = 2·3.
Inset. Resolution curve of the coincidence circuit for boron-10 proton – gamma-ray coincidences (330-keV. deuterons) not corrected for random counts

counts gave a range of 25·2 cm., as would be expected if the gamma-rays were associated with the short-range group. A lithium-6 target (7·6 µgm. cm.$^{-2}$) was used and gave a maximum of 3·25 coincidences per microcoulomb with a real-to-random ratio of unity and less than 0·15 background coincidences per microcoulomb beyond the long-range group.

A lead absorption measurement on the coincident gamma-rays gave 510 ± 25 keV. for their energy, in agreement with the energy difference of the proton groups measured by Buechner *et al.*[1].

$B^{10}(dp)B^{11}$. Similar results were obtained from the bombardments of natural boron and of boron-10, and those from the separated isotope target are given in the graph. As expected, the measurements show that gamma-rays are to be associated with the two shorter-range groups and not with the third.

Figs. *B* and *C* show that there are 3·5 times as many protons in the first as in the second group. The emission of these protons leaves boron nuclei in excited states[2] at 4·47 and 2·15 MeV., and, if gamma-radiation leads directly to the ground-state in each case, it will consist of 4·47 and 2·15 MeV. quanta in the same ratio of 3·5 : 1. The observed intensity ratio for the coincident gamma-radiation (Fig. *A*) was 3·4; this could be changed by altering the gain of the gamma-ray detector, as would be expected if the gamma-rays were of widely different energy. If, on the other hand, the 4·47-MeV. level emits two 2-MeV. gamma-rays in cascade, a ratio of 7, substantially independent of gain, would have been obtained. It follows that the shorter-range protons are predominantly associated with single gamma-ray transitions to the ground-state of boron-11, as was found also by Thirion[3]. This was confirmed by absorption measurements taken on the coincident gamma-rays which gave absorption coefficients of 0·34 cm.$^{-1}$ in lead for each of the first two groups, and in copper 0·15 ± 0·05 cm.$^{-1}$ for the first group and 0·25 ± 0·04 cm.$^{-1}$ for the second group. These are lower than the theoretical values given by Heitler[4], probably because of the poor geometrical conditions.

The good agreement between the proton and gamma-ray intensity ratios shows that, under the experimental conditions, the smaller pulse-size due to the 2·15-MeV. gamma-quanta was compensated for by the larger Compton cross-section, so that the detection efficiency was about equal for the two energies. The efficiency was found to be 7 per cent, assuming the absence of proton-gamma angular correlation. This corresponds to detection of practically all the Compton electrons for the 4·47-MeV. gamma-ray as calculated from the Klein–Nishina formula for the thickness (2 cm.) of the anthracene-loaded naphthalene used.

Coincidences between protons and gamma-radiation have previously been observed in (α,*p*) reactions[5,6], but with rather slow counting-rates. In the present experiments, the small resolving time of 15 millimicroseconds permitted a high disintegration-rate and hence a high coincidence counting-rate (~ 20 per sec. for lithium, and ~ 100 per sec. for boron) with a good real-to-random ratio. Resolving times as short as 5 millimicroseconds could probably be obtained[7], but this may be near the limit[8] set by the photomultiplier. However, the present technique offers good prospects for a much more detailed study of the properties of the gamma-radiation emitted in (*dp*) reactions.

We wish to thank Dr. W. E. Burcham for advice and encouragement throughout this work. We are grateful to Sir John Cockcroft and the Atomic Energy Research Establishment Harwell, for assistance; Dr. W. D. Allen's group provided the separated targets, and Mr. E. H. Cooke-Yarborough advised us on the design of coincidence circuits of small resolving time. [May 24.

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INDUCTION OF MUTATION IN *MICROCOCCUS PYOGENES* BY CHEMICAL INACTIVATION OF SULPHHYDRYL GROUPS

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AND

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BARRON *et al.*[1,2] reported that the first point of attack in enzyme systems which were irradiated by X-rays, alpha-rays, beta-rays and gamma-rays was the sulphhydryl groups of the enzyme proteins. If inhibition of the sulphhydryl-containing enzymes was only partial, reactivation could be accomplished by addition of glutathione. The emphasis on peroxide in recent work on mutagenic action suggests that one point of attack of radiations in inducing mutation might also be at sulphhydryl groups of the gene protein.

Colwell and McCall[3] found that the antibacterial and antifungal activity of 2-methyl, 1-4 naphthaquinone was due to the blocking of sulphhydryl groups on enzymes or metabolites essential for growth. Stable small colony variants of four strains of *Escherichia coli* were produced in large numbers in a synthetic medium containing this vitamin K homologue in sublethal concentrations[4]. The affinity of this naphthaquinone for —SH groups is well known in organic chemistry[5].

The purpose of this work was to determine whether this naphthaquinone could induce antibiotic-resistant mutants in *Micrococcus pyogenes* var. *aureus*, and to determine if such mutagenicity was due to —SH inactivation. Menadione (2-methyl, 1-4 naphthaquinone, Merck) was dissolved in 80 per cent acetone (which yielded a sterile solution) to give a final concentration of 0·3 per cent, then added to nutrient broth in amounts sufficient to give the desired final concentrations. Aliquots of the menadione-treated nutrient broth were allowed to stand at room temperature for one hour prior to inoculation with 0·1 ml. of a log-phase culture of *Micrococcus pyogenes* var. *aureus*, *FDA* strain 209. After 18 hr. incubation

Table 1. EFFECT OF VARIOUS CONCENTRATIONS OF MENADIONE ON THE INCIDENCE OF MUTANTS IN *Micrococcus pyogenes*

Addition to medium	Penicillin-resistant*	Streptomycin-resistant*
Untreated control	1·0	1·0
Acetone, 3%	1·4	1·3
Menadione, 12 p.p.m.	no growth	no growth
,, 6 ,,	21·0	4·6
,, 3 ,,	8·2	3·2
,, 1 ,,	3·0	2·1
,, 0·5 ,,	1·8	1·6

* Results expressed as relative numbers of mutants per million cells with controls taken as unity.

the resulting cultures were assayed for penicillin and streptomycin-resistant mutants by the method of Stone *et al.*[6].

Table 1 shows the effects of various concentrations of menadione in increasing the numbers of drug-resistant organisms in the population. The acetone control shows that the result was actually due to the menadione and not to the solvent. Both streptomycin and penicillin-resistant colonies were isolated and found to retain their resistance after repeated transfer on plain nutrient agar. Further tests showed that the increase in mutants occurred soon after inoculation, indicating that the selective action of the environment was not a major factor in their appearance. Another factor which aids in ruling out selection is the number of different mutations which this compound has been found to induce. Besides mutations to penicillin and streptomycin resistance, menadione also induces small colony variants in *E. coli*[4], and induces mutation of *M. pyogenes* towards inability to ferment mannitol[7]. It is unreasonable to assume that the same selective factors should be operative in each case.

Table 2. ACTION OF CYSTEINE IN INACTIVATING THE MUTAGENICITY OF MENADIONE IN *Micrococcus pyogenes*

Addition to medium	Penicillin-resistant*
Untreated control	1·0
Menadione, 6 p.p.m.	7·7
Menadione + cysteine	2·2
Cysteine added to substrate prior to addition of menadione	5·0
Cells grown in presence of menadione five hours, then cysteine added	7·0
Cells grown in presence of cysteine five hours, then menadione added	1·5

* Results expressed as relative numbers of mutants per million cells with controls taken as unity.

To test for the possibility of this mutagenicity being the result of the inactivation of sulphhydryl groups, cysteine, in a ten-molar excess, was utilized as a source of —SH groups. As shown in Table 2, if cysteine is allowed to react with the menadione and the resulting compound is added to the substrate prior to inoculation, the major part of the mutagenicity is lost. Glycine failed to exert a similar action, indicating that the inactivation was not due to the amino-group. If cysteine is added to the substrate prior to the addition of the menadione, little of the mutagenic effect is lost. Possibly in these circumstances the cysteine competes with other components of the substrate for reaction with the menadione; if the menadione reacts with the cysteine it is inactivated, but, if it reacts with some other component of the substrate, the resulting compound either induces the mutation or protects the menadione from the inactivation by the cysteine, yet still allows it to react directly with more reactive groups in the gene complex. If *M. pyogenes* cells are grown in the presence of menadione for five hours before the addition of the cysteine, there is little or no interference with the mutagenic action. However, if the cells are grown in the presence of cysteine for five hours before the addition of menadione, the major part of the mutagenicity is lost. Possibly in the latter case the cells become saturated with such an excess of —SH groups that the menadione has no appreciable effect.

Other compounds containing sulphhydryl groups, such as methionine, glutathione and sodium thioglycollate, were tested and were found to interfere with mutagenic activity of menadione.

Fildes[8] demonstrated that the antibacterial action of mercury and its salts could be ascribed at least in part to its interference with —SH groups. This same action probably applies also to copper and silver salts. In consideration of this action, sub-lethal concentrations of mercury, silver and copper salts were added to nutrient broth aliquots, which were then inoculated with *M. pyogenes*, and the resulting cultures assayed for antibiotic-resistant mutants.

Table 3. EFFECT OF 'HEAVY METAL' SALTS ON THE INCIDENCE OF MUTANTS IN *Micrococcus pyogenes*

Addition to medium	Concentration	Penicillin-resistant	Streptomycin-resistant*
Untreated control	—	1·0	1·0
Mercuric chloride	0·1 p.p.m.	1·2	1·6
Merthiolate	0·0005 p.p.m.	0·6	0·8
Copper sulphate	0·01 p.p.m.	0·5	0·8
Silver nitrate	0·01 p.p.m.	0·3	0·7

* Results expressed as relative numbers of mutants per million cells with controls taken as unity.

As shown in Table 3, none of these compounds exhibited any mutagenicity. The slight increase of mutants in the culture treated with mercuric chloride is within experimental error. On the basis of these results, it seems that the mutagenicity of menadione is not due to a mere inactivation of sulphhydryl groups, but it is somewhat more complex. Possibly a matter of accessibility is involved. A biological compound such as a vitamin K homologue might have more free movement within a cell than a foreign metallic ion, and thus might be able to react with genetic material which is fairly well protected within the cell. Or if the heavy metal reacts with such material, the reaction may be more drastic and cause death of the cell rather than the induction of a viable mutant. The significance of the reduction in the incidence of spontaneous mutation by the action of the 'heavy metals' is unknown; in this case a possible selective action by these metals has not been ruled out. Also it is still not determined whether the —SH block exhibited by the menadione is in the protein component of the nucleoprotein or in some enzyme which is essential to gene duplication.

The fact that compounds may react with the same groups in the cell but yield different effects on non-specific mutations suggests that this approach eventually may lead to a procedure for securing specificity in mutagenic action.

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USE OF *ASPERGILLUS NIGER* AS A TEST ORGANISM FOR DETERMINING MOLYBDENUM AVAILABLE IN SOILS TO CROP PLANTS

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Long Ashton, Bristol

IT is known that, in addition to the macronutrients nitrogen, phosphorus, potassium, magnesium and sulphur, the micronutrients iron, zinc, copper, molybdenum, manganese and possibly gallium and vanadium are essential for the normal growth and metabolism of *Aspergillus niger*[1-8]. The fungus has been used by Smit and Mulder as a test organism to study the magnesium and copper status of Dutch soils[9]. Mulder[2,3] has also used the bio-assay method to determine molybdenum-levels in soils; but deficiency values were not recorded.

We have recently determined deficiency levels of molybdenum in British soils where cauliflower (*Brassica oleracea*) showed 'whiptail' effects. This disorder in the Brassica family appears to be due to a deficiency of molybdenum, although other factors may be contributory[10-12]. Davies[13] and Waring *et al.*[14] have reported a correction of 'whiptail' in cauliflower in New Zealand and Australia respectively, by applying sodium or ammonium molybdate to the soil. More recently, Jones[15] and Plant[16] have confirmed these responses in instances of 'whiptail' in Britain.

Aspergillus niger (M.), kindly supplied by Dr. E. G. Mulder, Grőningen, was used in this study. The basal culture solution used has the following constitution:

Dextrose	50 gm.	$FeCl_3.6H_2O$	3 mgm.
KNO_3	5 gm.	$MnSO_4.4H_2O$	0·3 mgm.
KH_2PO_4	0·6 gm.	$ZnSO_4.7H_2O$	2·0 mgm.
$MgSO_4.7H_2O$	0·6 gm.	$CuSO_4.5H_2O$	0·6 mgm.
$CaSO_4.2H_2O$	0·5 gm.	$Ga(NO_3)_3.8H_2O$	0·2 mgm.
		$Co(NO_3)_2.6H_2O$	0·10 mgm.
		$Ni(NO_3)_2.2H_2O$	0·08 mgm.

The above salts are contained in a litre of water distilled from a copper still and then twice from 'Pyrex' glass.

To produce molybdenum-deficiency effects in *Aspergillus niger*, Steinberg[6-8] and Mulder[2,3] used mineral nutrients which were spectrographically free from the micronutrient. Our method, which involves a chemical purification of the inorganic macronutrients and dextrose that comprise the culture solution, is as follows. The mineral macronutrients and dextrose are dissolved in 200 ml. of glass-distilled water, and sufficient 2 *N* hydrochloric acid (redistilled) is added to adjust the *p*H of the culture solution to 3·0. 1 ml. of a 5 per cent solution of copper sulphate and lead nitrate respectively are added, as well as 10 μgm. molybdenum as sodium molybdate, and hydrogen sulphide passed through the solution for 15 min. The colloidal molybdenum sulphide is co-precipitated with the other metallic sulphides. The precipitate is allowed to stand for a few hours and then filtered through an acid-washed No. 42 Whatman paper into a 1-litre 'Pyrex' conical flask. The hydrogen sulphide is eliminated from the solution by boiling, and lead acetate paper is used to confirm its complete removal. After cooling, the micronutrients (except molybdenum), which have been recrystallized twice from glass-distilled water using redistilled alcohol to enhance yields, are added. The culture solution is then made up to 950 ml., adjusted to exactly *p*H2 using redistilled 2 *N* hydrochloric acid, and finally made up to a litre, using glass-distilled water. 50-ml. portions of solution are poured into 1-litre 'Pyrex' conical flasks or 6-in. Petri dishes, which have been thoroughly cleaned with acid and finally rinsed with glass-distilled water.

Table 1. RELATION BETWEEN MOLYBDENUM STATUS OF CULTURE SOLUTION AND THE GROWTH OF *Aspergillus niger* after SIX DAYS INCUBATION AT 25° C.

μgm. Mo in 50 ml. culture solution	Description of mycelium and sporulation	Dry weights of fungus (mgm.). Mean of six determinations	*p*H of culture solution after incubation
0	Thin isolated strands of mycelium, entirely mucous	57	2·56
0·0001	Thin strands of mycelium, forming thin pellicle	114	2·92
0·0005	,, ,, ,, ,,	174	3·49
0·001	Thicker pellicle, entirely mucous	275	3·58
0·002	,, ,, ,, ,,	400	3·88
0·005	Occasional black spores on small islands of white hyphal growths alternating with mucous areas	537	1·67
0·01	Thicker mycelium, scant sporulation	638	2·18
0·02	Thick undulating mycelium, abundant sporulation	795	2·19
0·05	Very thick mycelium, complete black spore cover	950	2·10

Another effective method of removing molybdenum is a modification of that proposed by Waring and Werkman for iron[17]. 5 ml. of 2 per cent solution of 8-hydroxyquinoline in 2 *N* acetic acid is added to a solution of the macronutrients and dextrose (100 ml.) at *p*H 5·5 in the presence of 10 mgm. iron and incubated at 35° C. for 24 hr. The solution is filtered through a No. 50 Whatman paper, and redistilled ether is used for removing excess 8-hydroxyquinoline. The ether is eliminated from solution at 80° C. Using either method, the dry weights of mycelia from cultures omitting molybdenum, using 50-ml. portions, varied from 27 mgm. to 89 mgm. The addition of a range of other metals at 0·05 μgm. per 50 ml. culture solution did not appear to affect the growth curve, thus indicating the specificity of the response to molybdenum.

For soils tests the following standard series for molybdenum is used: 0·5, 1, 5, 10, 20, 30, 40, 50, 100, 200, 500 μgm. × 10^{-4} respectively. The most sensitive range is 0·5–50 μgm. × 10^{-4} per 50-ml. culture solution. The test flasks or Petri dishes are sterilized and inoculated with four drops of a spore

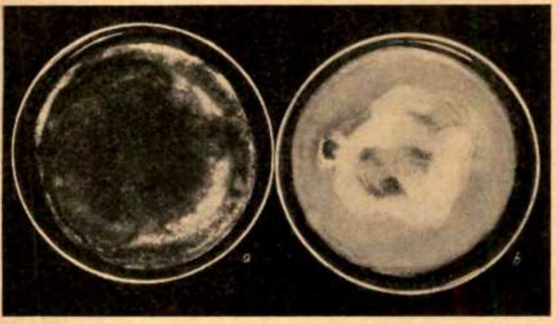
Table 2. RELATION BETWEEN VISUAL SYMPTOMS, MOLYBDENUM STATUS OF CAULIFLOWER (LEAVES) AND SOILS

Location	Parent material of soil	Visual symptoms in cauliflower	Chemical analysis of cauliflower leaves. (Mo as μgm. per gm. dry weight)	Bio-assay of Mo in soils as μgm. per gm. air-dry soil
Long Ashton, Somerset	New Red Sandstone	No 'whiptail'	1 to 5	> 0·5
Bromham, Wilts	Lower Greensand	'Whiptail' symptoms, rudimentary aborted growing-points, absence of leaf lamina	0·02–0·10	0·01
St. Ives, Cornwall	Devonian	,,	0·02–0·08	0·015–0·03

suspension of *Aspergillus niger* and incubated at 25° C. for six days. In Table 1 are given details of the growth series.

It is important to take soil samples for test from the rooting zone of the plants. Half-gram portions of air-dried soil are put in the sterilized culture solutions free from molybdenum, and then after inoculation the flasks are incubated as for the standard series. Three results of the bio-assay method are shown, together with results of other methods in Table 2. The two 'whiptail' soils were kindly supplied by Dr. William Plant from his experimental centres[16].

It is clear from Table 2 and the accompanying illustration that there are significant differences between molybdenum-level of 'whiptail-free' soils and those from areas where 'whiptail' symptoms in cauliflower are pronounced. The range of values so far obtained for soils deficient in molybdenum is 0·01–0·03 μgm. molybdenum, whereas normal soils usually have more than 0·5 μgm. molybdenum per gm. air-dry soil.



(*a*) Soil from Long Ashton showing an adequate molybdenum level (> 0·5 μgm. per gm. air-dry soil)

(*b*) Soil from 'whiptail' area showing a deficiency of molybdenum (0·03 μgm. per gm. air-dry soil)

The extreme sensitivity of the bio-assay method for the determination of levels of molybdenum, associated with sufficiency and deficiency of the micronutrient in soils, makes it preferable to chemical methods which are relatively ineffective for such a low range of values.

A full account of this and related work will appear elsewhere. [Feb. 22.

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EFFECT OF *p*H ON THE BIOLOGICAL ACTIVITY OF WEAK ACIDS AND BASES

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A RECENT study[1] of the toxicity of some simple nitro derivatives of phenol to the fungus *Trichoderma viride* revealed a general relationship between *p*H and the toxicity of a weak acid or base. The upper curve in the accompanying graph shows the effect of *p*H on the concentration of a weak acid required to produce a standard response, such as bacteriostasis, from the test organism. Changes of *p*H have no influence on toxicity at *p*H-levels below *pK*; but at higher *p*H-levels the concentration required for the standard response increases rapidly, indicating a fall in toxicity. The concentrations of undissociated molecules corresponding to these total concentrations of weak acid are shown by the lower curve, and it will be seen that the concentration falls at *p*H-levels above *pK*. It has been pointed out[1,2] that since a constant concentration of undissociated molecules does not produce the same response at each *p*H-level, it cannot be held that the undissociated molecules alone are responsible for toxicity.

It has now been shown that *p*H influences many other biological activities of weak acids and bases and that the magnitude of the effect of *p*H is in each case of the same order as that shown in the illustration. In addition to the original observations on *Trichoderma*, the effect of *p*H on the following activities has been investigated; where no reference is given, the work is original.

(*a*) Inhibition of the respiration of bakers' yeast by the nitro derivatives of phenol.

(*b*) Inhibition of yeast respiration by iodoacetic and hydrazoic acids[2], hydrocyanic acid, hydrofluoric acid, *n*-butylamine and phenyl hydrazine.

(*c*) The toxicity of various weak acids and bases to bacteria, fungi, insect eggs, Protozoa, etc., for which data are available in the literature[1].

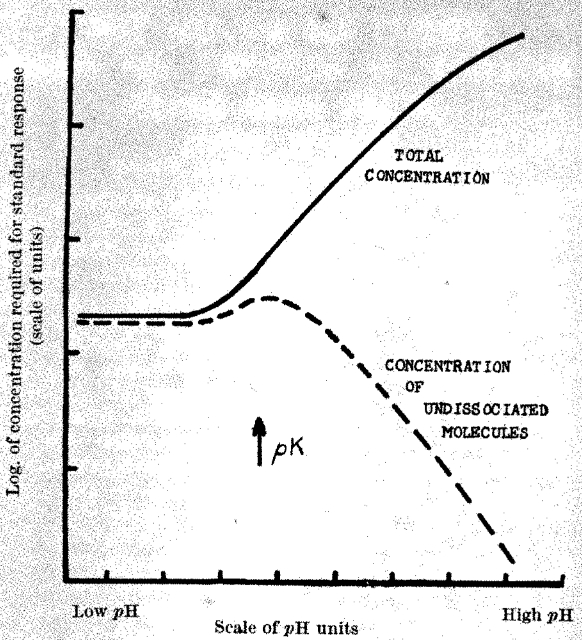
(*d*) Inhibition of yeast fermentation by 3 : 5-dinitro *o*-cresol.

(*e*) Stimulation of yeast respiration by low concentrations of 3 : 5-dinitro *o*-cresol.

(*f*) The activity of β-indoleacetic acid and similar acids in the pea test[3], and of β-indoleacetic acid in the oat cylinder test.

(*g*) The activity of *p*-amino benzoic acid in promoting the growth of a *Neurospora crassa* mutant[4], and of nicotinic acid in promoting the growth of *Staphylococcus aureus*[5].

It is clear from this list that the illustration represents the effect of *p*H on a very wide range of biological activities varying from toxicity to growth-promotion. The figure is based on an examination of more than eighty graphs, and the upper curve can be used to predict the effect of a given *p*H change on the activity of a particular weak acid or base. For example, it provides a basis for comparing the experimental results of authors who have used a respiratory inhibitor or a growth substance at different *p*H-levels. It may also be of value in measuring the activity of a range of weak acids. The activity of a weak acid, as determined by experiment, depends not only on the intrinsic activity of the compound but also on the *p*H at which activity is measured. It has been shown[1] that the measure of activity most appropriate for studies of the relation-



The effect of pH on the concentrations of a weak acid that are required to give a standard response from the test organism. The corresponding graph for a weak base is obtained by reversing the pH scale

ship between activity and chemical structure or physical properties is the activity measured at a pH at which there is little or no dissociation. A pH of 2 or more pH units below pK was recommended; but this may not always be practicable. Thus there are few organisms that could be used to measure the activity of a carboxylic acid of pK 4 at a pH of 2. In such a case, the measurements should be made at a convenient pH, say pH 7, and the graph can then be used to make a correction for the varying degrees of dissociation of the different compounds.

Several departures from the simple relationship shown in the graph have been found, and work on them is still in progress. One of the most interesting exceptions is observed when the test organism is large in comparison with the volume of the external solution, as, for example, when 3 : 5-dinitro *o*-cresol is sprayed on to seedlings of mustard. The pH of the spray solution has only a very slight effect on toxicity (between pH 4 and pH 8 toxicity only changes by one-hundredth of that shown in the graph)[6]. There are two principal paths by which 3 : 5-dinitro *o*-cresol can enter the leaf tissue—diffusion in the vapour phase through the stomata, and penetration in the liquid phase through the cuticle followed by passage from cell to cell within the tissues. It is suggested that in either case the toxic material will always reach the cells at about the same pH-level—a pH related to that of the cells and scarcely affected by the pH of the spray solution. If steps are taken to ensure that the individual cells of the leaf are bathed in the buffered toxic solution, for example, by vacuum infiltration of leaf disks of mustard, it is found that pH changes influence toxicity to the extent shown in the graph.

In a similar way, the full influence of pH on toxicity is masked in other instances where a small quantity of a buffered solution of the active substance is applied to a relatively large bulk of tissue and is transported from cell to cell within the tissue, for example, the *Avena* curvature test[7], the tomato leaf epinasty test[8] and the rooting response of tomato cuttings[9].

This work will be presented for publication in detail elsewhere.

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INFILTRATION TO UNDERGROUND OF RAINWATER

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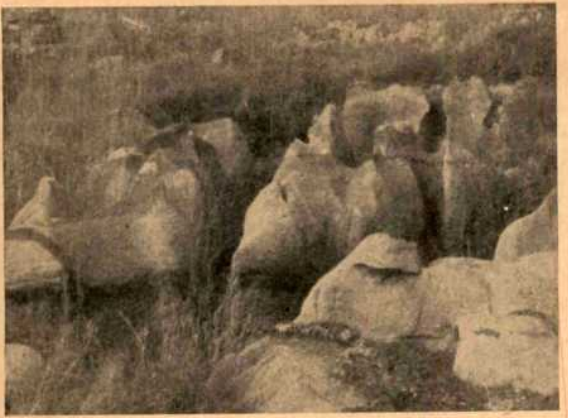
THE manner in which rainwater reaching the earth's surface is distributed has rarely been determined in detail, and then only in very local conditions. Its importance in modern agriculture[1] has not been appreciated fully, for extensive determinations have not been made. Lysimeter experiments are not, of course, recent innovations; but how far their results can be extrapolated to a catchment area is a very difficult matter to determine. Run-off and rainfall data have reached a high degree of accuracy[2], and in most cases the evaporation from free water surfaces is also available; but how to relate these and deduce the infiltration to underground is not a simple matter. Naturally a great deal will depend upon the type of vegetation, and for cultivated areas this is going to vary according to the crop[3].

South Africa is dependent upon underground water, and the infiltration to underground is of very great importance. For certain reasons, lysimeter experiments, which may be useful for agricultural experiments, may be dangerous to apply in wider hydrological problems. Theron's[4] experiments near Pretoria, for example, have limited application over South Africa. For example, our rainfall is highest in the mountainous areas and our mountain slopes are mainly noted for the waste rock that fill the foothills[5]. Run-off is nil in these structures, and water rapidly moves through the open texture of the boulder gravels and soon is safe from evaporation losses. It is probably in such areas that more than 50 per cent of the total precipitation goes to underground, whereas in other areas the order is that indicated by Theron, say 3 per cent.

The late Dr. A. L. du Toit[6] approached the problem in another manner. On the eastern portion of the Witwatersrand, the terrain is flat and consists of gently undulating dolomitic limestones with a variable covering of clays and sandstones of the Karroo System. The older rocks of the Witwatersrand System are also relatively flat-lying and have been extensively mined, so that the water pumped from these mined areas represents a very high proportion of the underground water of the area. Du Toit worked out that the water pumped out amounts to about 3 per cent of the total rainfall of the area. Here is a case of a gigantic lysimeter, and the method could be applied more extensively. For example,



Typical rock structure just below the soils of the Dolomitic limestones. The joints have been opened up by solution and water is now confined to a channel, thus builds up a greater head than if distributed evenly laterally and hence feeds to the underground reservoirs. To reconstruct this in a lysimeter or even simulate it in an approximate manner would be very difficult if not impossible. Vast areas of the dolomite present this structure under a thin soil cover

the western extension of the Witwatersrand lends itself to the same experiment. Now the dolomite covers a very great area in South Africa and, owing to the fact that the rock develops very large and extensive solution channels and underground caves[7], lysimeter experiments of the order of a third of an acre or less (unless they take into account such efficient media for rapidly leading water underground) would give figures that are far too low for the infiltration to the dolomitic limestones.

The South African landscape from the Western Province through the Northern Cape, Free State and the Transvaal into Southern Rhodesia is characterized by closed drainage areas or pans. These pans collect appreciable volumes of water and should act as efficient structures for forcing water underground. However, the fact that most of them contain greater quantities of salts in solution than rivers in the same areas suggests that underground drainage is not a rapid matter, and it is possible that from salinity studies the infiltration to underground could be evaluated. The pans occur over many geological formations and all over South Africa, and it means that results would be of wide application.

Studies of several dams show that the infiltration to underground varies a great deal. In some cases there is an undoubted flow to voids in rocks deeper down; but in others there is a gain from a source which can only be underground water issuing from springs. Boreholes drilled along the edges of dams, although well below the water-level and only a short distance (less than 1,000 ft.), gave such small yields (less than 20 gall. per hr.) that lateral flow from the dam could not be great. Many of our dams, for example, Haartebeestpoort Dam, are built in fault lines[8], so that ample and permanent supplies of underground water occur on the downstream side.

It appears that, if the elements of the hydrological balance are to be determined in South Africa, the mines of the eastern and western Witwatersrand, coal mines of the Witbank area and the dams and pans of South Africa can give a great quantity of data on underground infiltration, and that such data may be far more generally applicable than lysimeter experiments—of course, only so far as the infiltration to underground is concerned. It is an unfortunate circumstance that in the case of the Orange Free State gold mines the presence in certain areas of artesian water in the sediments of the Ventersdorp System (water derived probably from the Basutoland Highlands) will prevent the pumpage from those mines being useful in the evaluation of underground recharge in that area.

The Okavango Delta in the northern portion of Bechuanaland could be used to great advantage[9]. Presenting probably a very close approach to a free water surface, evaporimeters plus flow measurements of this river could give a valuable guide to the amounts of water that are fed to underground, and hence of the underground waters of the southern Kalahari and parts of South-West Africa. This would be invaluable in the development of Southern Bechuanaland.

With anxiety being felt of the lasting qualities of our underground waters, it is remarkable that, in the low rainfall areas of the Karroo, boreholes and springs of great yield are found, for example, the flowing springs of Cradock and Aliwal North. West of De Aar in areas of rainfall less than 12 inches, fresh and saline boreholes of 2,000–8,000 gall. per hr. occur within close proximity. In these areas surface limestone and extensive sand stretches facilitate infiltration to underground, and hence a high proportion of the rainfall is made available for subsurface flow. While in high-rainfall areas probably only 3 per cent of the total precipitation (say, more than 24 inches per annum) goes to underground, in these areas 60 per cent of the 12 inches precipitation may rapidly filter to the subterranean storage and flow.

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BONE AND TOOTH SOCIETY

A NEW society has recently been formed which has the object of providing a discussion ground for those interested mainly, but not exclusively, in fundamental laboratory investigations in bones and teeth. At its first meeting on March 24, it was decided to hold quarterly meetings at which there would be symposia on various aspects of bones and teeth, and there would also be meetings for casual communications where there would be opportunity for discussion by a more specialized audience than might be met with at other scientific society meetings having a more general interest.

An interim committee to look after the Society's interests in various branches, during its formative stage, was elected as follows: Mr. Ivor Kramer, representing dental interests, Dr. C. H. Lack, clinical, Dr. J. J. Pritchard, anatomical, Dr. H. J. Rogers, biochemical, and Dr. H. A. Sissons, histological. Dr. T. F. Dixon, Institute of Orthopædics, Royal National Orthopædic Hospital, 234 Great Portland Street, London, W.1, was elected secretary.

The Society had its first scientific meeting at the Institute of Orthopædics, 234 Great Portland Street, London, W.1, on June 6. This took the form of a symposium on bone structure at which Prof. W. D. Newcomb took the chair. Dr. H. B. Fell discussed the origin and developmental mechanics of the embryonic skeleton in warm-blooded animals, and described experiments relating to the origin of chondrogenic and osteogenic tissue in the early embryo, the capacity of embryonic skeletal tissue for regeneration and regulation and the relative importance of intrinsic and extrinsic factors in the gross anatomical development of the skeleton. Dr. H. A. Sissons gave an account of the microscopic structure of various types of bone, as seen in the mature skeleton and in embryonic development. He outlined the cellular processes concerned in endochondral and membrane bone formation, and discussed lamellar bone, non-lamellar bone, and osteoid tissue from the histological point of view. Dr. J. J. Pritchard described the evolution of bone structure. He gave a brief assessment of comparative, embryological and palæontological evidence, and referred to the earliest appearance of bone in the geological record. He discussed the question whether bone or cartilage appeared first in evolution, and the possibility of their simultaneous origin in view of the close ties between the two tissues. He also described the possible derivation of endochondral bone from membrane bone and the evolution of different types of bony structure culminating in the plastic Haversian systems of large mammals (and large extinct reptiles) with special emphasis on vascular patterns. Dr. T. F. Dixon showed how wide fluctuations in inorganic composition of bone occur under the influence of a variety of conditions; for example, as might be expected from the histological structure, in the same animal there are variations from one bone to another and in different parts of one bone. Dietary variations produce changes in composition and so on. From chemical and such physical examinations as X-ray diffraction patterns and differential solubility measurements, the mode of combination of the inorganic elements can be elucidated. There is still, however, disagreement as to the precise molecular composition. Dr. H. J. Rogers described experiments on the protein and mucopolysaccharide components of the organic matrix of bone, and gave an indication of the identity of the sugars present in the latter.

The Society proposes to have a full programme this winter; the next meeting will probably be held at the Eastman Dental Clinic, Gray's Inn Road, London, W.C.1, on October 3, when a symposium on "Tooth Structure" will be held.

MANAGEMENT AND WORKERS

At their annual conference at Buxton in April 1950, members of the National Institute of Industrial Psychology pooled their theories and experience to formulate an ideal personnel policy for an industrial organisation. To give the proceedings greater reality, the organisers presented the conference with a detailed description of a hypothetical company about to begin production of a nutritious food-stuff.

Before splitting into five committees, the conference was given some general suggestions by Sir Patrick Hamilton, chairman of Henry Simon, Ltd., and Mr. D. S. A. E. Jessop, personnel director of the Brush Electrical Engineering Co. Sir Patrick thought that the schemes adopted should be capable of modification as the organisation developed and issued a warning against allowing concentration on modern techniques to obscure such principles as honesty, sincerity, fairness and approachability. Mr. Jessop said success would depend largely upon the employees' understanding of the firm's overall working, of its objectives and of their enthusiasm for the venture. The spread of knowledge of what was going on, the possibility of everyone having his suggestions or criticisms heard or acted upon if valid, was what he understood by joint consultation and control, and not the mere division of managerial responsibility among a committee. Effective co-operation depended upon mutual confidence and on assured security in return for a job well done.

The first committee to report back to the plenary session suggested selection methods for appointments to supervisory and management jobs, which would generally place employees in jobs in which they would succeed and find satisfaction. The training committee decided to arrange not only for appropriate training for every grade in techniques, processes and methods of work which would be new to them, but also for a general course on the firm's organisation and production. This would show how each individual or group contributed to the whole.

Another committee dealing with methods of work and environment set before itself the question of maximum output with the minimum of strain. It considered diverse ways of ensuring the cleanliness desirable in a food factory, the best hours of work for a labour force to be composed mainly of women, the prevention of noise, pleasantness of surroundings and general welfare.

A further committee was concerned to see that management direction should be disseminated quickly and accurately through the works and that those in authority should know what was happening below and deal quickly with suggestions of dissatisfaction. They recommended verbal reports to employees on management problems, policy and financial matters, close co-operation and exchange of information between foremen, shop-stewards and between one individual and his immediate subordinate as well as the usual methods of spreading information.

The only committee to show a serious difference of opinion was that concerned with methods of payment. The majority of its members wanted generous weekly time-rates and the others some form of payment by results. All were agreed that wage-rates should be based on work measurement and some form of job evaluation and that a pension scheme and ultimately a profit-sharing scheme should be introduced. The majority believed that maximum output could be achieved by good supervision and encouraging a good team spirit; the minority that individual incentives are necessary in an imperfect world.

The final speaker was Mr. Giles Howard, of Hayward–Tyler and Co., Ltd., who said he would delegate responsibility within the firm and would see that there would be no over-ruling from above. But though responsibility was granted from above, they must remember that authority came from below. The firm's policy would be wise not clever and based on Christian ethics which were not incompatible with efficiency.

Summing up, General Sir Ronald Adam, chairman of the Institute, said that successful methods of selection using job analysis could be put into operation in industry now, as could efficient training for supervisory posts. Good methods of disseminating knowledge throughout a firm existed and, given the right attitude, could be successful. He was in favour of selection methods being applied to rank and file jobs.

LETTERS TO THE EDITORS

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Thickness and Structure of the Membrane of the Human Red Cell Ghost

WHEN mammalian blood is mixed with a large volume of glycerol, the red cells are hæmolysed and produce spherical ghosts of about the same diameter as red cells of spherical form. The membrane of the ghosts is birefringent; the optical axis lies radially, and the sign of birefringence is negative with respect to the tangent (Fig. 1). Since the ghost membrane shows little or no birefringence in saline, the negative intrinsic birefringence shown in glycerol must be compensated in saline by positive form birefringence. Schmitt, Bear and Ponder[1] concluded that the negative birefringence was due to radially oriented lipoid molecules, and that the strength of the birefringence was such that it must have been due to a layer of lipoid many molecules in thickness. It is now, however, known from physical and chemical measurements[2] that there is only enough lipoid present in a ghost to form a continuous layer over the surface about 50–100 A. in thickness (two to four molecules). The rest of the ghost is made up of the fibrous protein stromatin, in quantity sufficient to form a layer 50–150 A. thick when dry. No measurements of the thickness of the wet membrane have been made hitherto.

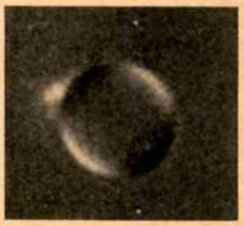

Fig. 1. Human red cell ghost in glycerol. Polarized light with compensation. × 2,300

I have developed a method of measuring the thickness of spherical or cylindrical membranes under certain conditions. It consists in measuring the retardation along a radial line which cuts the edge of the membrane. This gives a curve of retardation against radial distance. The shape of this curve is determined by the thickness of the membrane and the diffraction pattern in the microscope. The diffraction pattern can be calculated from theory and has been checked against models. When the diffraction pattern is known, the thickness of the membrane can be determined. This method has been applied to the human red cell ghost in glycerol, and the thickness of the wet membrane comes out at about 5000 A., or 0·5 μ, with an error of approximately ± 0·2 μ.

A rough check on this figure has been obtained by centrifuging ghosts (produced by hæmolysis with distilled water) with forces up to 110,000 *g*. The ghosts pack down to a volume about equal to that occupied by the same number of red cells. This might be expected, since a ghost membrane 0·5 μ thick would occupy about 55 per cent of the volume of an intact red cell.

This figure of 0·5 μ is surprisingly large, and is about ten times greater than previous estimates. Ponder[2] estimates the wet thickness of the red cell membrane to be 300–400 A. Evidence from electrophoresis, wetting properties and permeability indicates that the lipoid is predominantly at the surface. The membrane must, therefore, be largely composed of hydrated protein (stromatin), and the protein must be responsible for most of the negative birefringence. Taking the dry thickness between 50 and 150 A., it seems that the stromatin is in a gelated state at a concentration of between 1 and 3 per cent.

The red cell is shaped like a biconcave disk, and it has been something of a mystery how this apparently unstable shape is maintained if the envelope is only a few molecules thick. If, however, the membrane is as thick as 0·5 μ, the dimensions of the intact cell show that the inner edges of the membrane will just touch in the middle of the disk. The shape would then be much more stable.

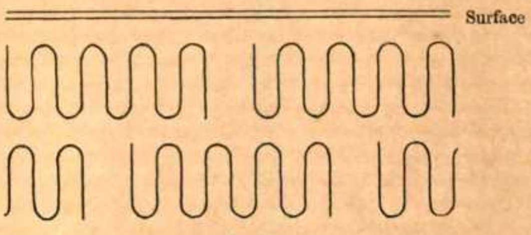

Fig. 2

Since a membrane of this thickness will occupy about 55 per cent of the volume of the intact red cell, it must contain large quantities of hæmoglobin within its structure. This may settle the controversy whether the red cell is a balloon filled with hæmoglobin in solution, or whether it is a solid jelly containing hæmoglobin. A red cell largely made up of a thick membrane containing hæmoglobin will fit the evidence for both these points of view.

This measurement of thickness indicates that the radial orientation in the membrane which causes the negative intrinsic birefringence is due to protein rather than lipoid. This implies that the membrane exhibits a new type of protein structure unlike the conventional picture of protein chains lying tangentially in the surface. A possible explanation is that the long stromatin molecules are arranged in looped bundles, like squibs or Chinese crackers. The bundles may be supposed to lie with their long axes running at random in the plane of the surface, but with the main parts of the protein chains within them lying radially (Fig. 2).

Such an arrangement would give the required negative intrinsic and positive form birefringence. A somewhat similar arrangement has been postulated by Rudall[3] to explain the cross-β X-ray pattern of epidermin, and Perutz[4] believes that there are looped protein-chains in hæmoglobin; but this is, I believe, the first evidence that such an arrangement may occur as part of the normal protein framework of living cells.

It is possible that other cell membranes may have a similar protein structure, since the membranes of amœbæ[5] and of sea urchin eggs[6] also show an increase in negative birefringence on immersion in liquids of high refractive index. It would, however, require more evidence than is yet available to prove this.

A full account of this work will be published elsewhere.

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Unusual Phosphatic Material in the Sutton Hoo Ship Burial

IN the course of an investigation to determine whether there was a body in the Sutton Hoo ship burial[1], chemical analysis has revealed some unusual phosphatic material derived from calcined bone. That this phosphatic material should have persisted after some 1,300 years is of the utmost importance when one considers that the acidic nature of the soil at Sutton Hoo[2] (subsoil sand, pH 4·5) does not favour the preservation of skeletal remains. In the whole of the burial deposit, the excavators thought they recognized only one small fragment of bone which they described as unburnt[3]. This piece, cancellous and brown in colour, was found on top of the largest of the silver dishes in close association with many fragments of wood, bark and iron. From visual examination only, a distinguished anatomist agreed with the excavators; but the opinion of others, based on more detailed examination, was that the fragment was not bone.

With its true nature still in doubt, the material came back to the British Museum Laboratory for chemical analysis. This showed it to be essentially a hydrated ferric phosphate containing only traces of calcium. When treated with dilute hydrochloric or nitric acids, minute carbon particles remained, and there was no trace of the collagenous structure that forms the residue when unburnt bone is so treated. The mode of distribution of these carbon particles throughout the material was seen, under the microscope, to be closely similar to that of the carbon particles in calcined bone, and there seems little doubt, therefore, that this phosphatic material was derived from this source.

A probable mechanism for its formation is suggested by the conditions under which it was found; while the acidity of the soil would favour the dissolution of calcined bone, the diffusion of corrosion products from the adjacent iron fragments into the bone structure would, by the deposition of insoluble ferric phosphate *in situ*, tend to form a 'cast' of the shape of the original material. This process of cast formation would be most likely to occur in those fragments of calcined bone actually in contact with metallic iron. In fragments remote from iron, it is probable that dissolution of the inorganic portion would proceed to finality with consequent loss of structure, thus releasing phosphate ions into the surrounding area. Where these met with iron corrosion products, amorphous ferric phosphate would be formed. Examination of all the material collected from the top of the silver dish supports this view. Besides other fragmentary examples of casts derived from calcined bone, a high proportion of which are 'cemented' to iron or its corrosion products, many pieces of wood were recognized to be heavily impregnated with amorphous ferric phosphate.

The formation of an insoluble product from burnt bone by contact with corroding iron under soil conditions that are unfavourable to the survival of bone (burnt or otherwise) is of considerable importance to the archæologist. The fact that this secondary material may be mistaken for unburnt bone (as, indeed, it was) will serve to emphasize the necessity of a very careful chemical examination of all fragments even remotely resembling bone, found in similar circumstances, particularly when questions of cremation or inhumation are involved.

A full report of the investigation will appear elsewhere.

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Effect of Posture on Involuntary Eye Movements

Lord and Wright, and afterwards Lord[1], have published records of involuntary movements made by the eye during fixation, showing excursions as great as twenty minutes of arc, whereas Hartridge and Thomson[2] only found movements of about one-tenth of this amount. The former workers had their subject in the prone position and looking upwards, in the interests of head fixation, while the latter had their subject erect and used a technique designed to discount the effects of head movements.

It seemed likely to me that these very different results were probably due to the loss of the support that the eye gets from Lockwood's ligament[3] when the subject is prone, rather than to any differences in the recording technique of these two sets of workers. It also seemed probable that if the difference in the size of the involuntary movements in these two positions was real, there should be an accompanying change in visual acuity.

The test object used to verify this assumption was a set of Landolt's broken rings, black circles of stroke thickness t and overall diameter $5t$ with a gap of width t at some point in their circumference. These were drawn in a symmetrical pattern on a square card. When in the prone position, the subject saw the card lying beside him on the floor, through a mirror fastened to the ceiling at an optical distance of 5·5 metres. The same mirror and the same optical distance were used for the erect position. The actual illumination on the card could not be recorded; but it was of the order of thirty foot-candles. In each case the same bulb was used at the same distance, and the equality of illumination was checked with a photo-electric exposure meter. Three sizes of ring were used, in which the element t subtended approximately 65″, 50″ and 40″ at the subject's eye, so that the diameter of the largest subtended about 5·5′.

In the prone position, subject A resolved all ten 50″-rings without error with each eye separately. Subject B made one error with his right eye and two with his left; neither subject could resolve any 40″-rings. In the erect position subject A made one error on the 40″-rings with each eye; subject B made one error with his right eye and none with his left. As a precaution against learning, advantage was taken of the symmetrical design of the test chart to turn it between observations and so produce a new arrangement.

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Effect of a Posture Change on Head and Monocular Fixation Eye Movements

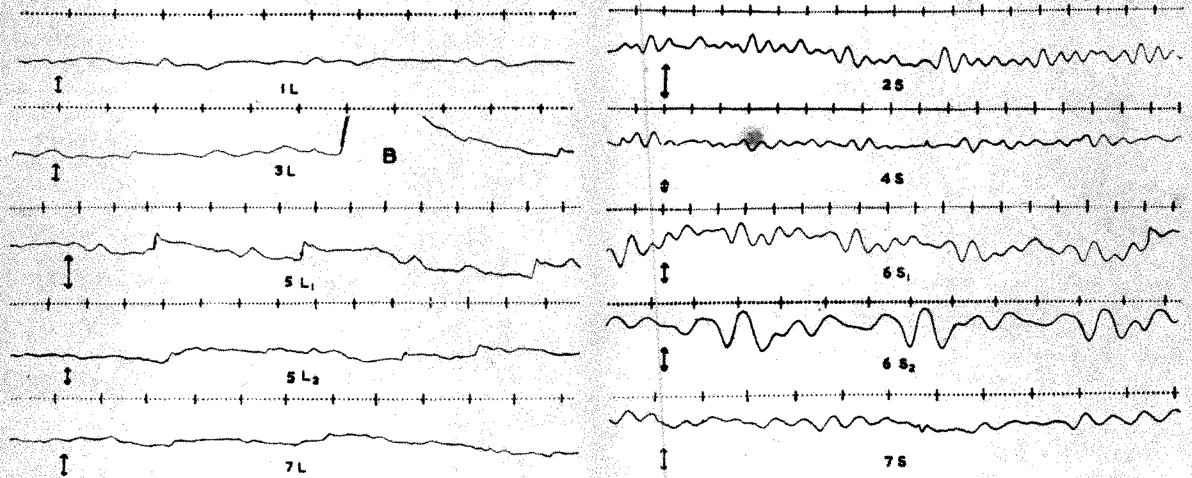
BINOCULAR fixation eye movement records[1] for subjects in the sitting position revealed a striking difference from monocular records[2] obtained with the subject supine. To decide whether the change of posture or the change to binocular vision was responsible for the difference, monocular fixation movements of the right eye have been investigated for seven subjects in the sitting position.

The method[1] of recording the eye movements is, in principle, identical with the photo-electric corneal reflex method used for supine observations[3]. At present, however, it is only possible to record the movements in one direction at a time. Head movements have also been recorded for those of the subjects whose teeth are sufficiently widely spaced to permit the rigid attachment of an artificial cornea to the skull by means of a dental regulation band; the artificial cornea was situated in front of the subject's right eye.

Head movement records for subjects W.D.W. and R.S.L. are shown in figures $1L$ and $2S$ respectively. As in the supine case, the movements are periodic, the period probably corresponding to that of the heart-beat. Day-to-day variations were found in the amplitude of the head-movement pattern. The average value of the maximum movement (about 0·025 mm. for both subjects) is some two and a half times larger than that found for W.D.W. in the supine position; moreover, the maximum displacement takes place sideways, whereas in the supine position it occurred longitudinally. The magnitude of the longitudinal movement is approximately the same for both positions.

Figs. 3–7 show eye records for some of the subjects for fixation, with the right eye, of a bright disk of angular diameter 1′. In almost all records the head-movement pattern can be picked out; its magnitude was found to show day-to-day variations: Figs. 6 S_1 and S_2 are side-to-side records for L.C.T. taken on May 10 and 31 respectively. Eye movement records for subjects W.D.W. and R.S.L. are shown in Figs. $3L$ and $4S$ respectively; the average maximum value of the head movements, as deduced from the side-to-side eye records, is 0·033 mm. for both these subjects. Whether the difference between this value and that obtained from the head records is due to day-to-day variations or to the fact that the subjects were not fixating when the head records were obtained will receive further investigation. The average maximum value of the head movements of all subjects was 0·038 mm.; the lowest average maximum value, of 0·021 mm., was found for subject M.P.L. (Fig. 7) and the highest, of 0·047 mm., for subject L.C.T. (Fig. 6).

The effect of the change of posture on the parts of the eye records presumably produced by rotations of the eye is also striking. For subjects W.D.W. and M.P.L. (Figs. $3L$ and 7 respectively), the average interval between the rapid flicks[2] is increased about threefold, that is, to 1·3 sec. for W.D.W. and to 2·3 sec. for M.P.L.; for subject R.W.G.H., however, for both positions, the average interval is 0·86 sec.: Figs. 5 L_1 and L_2 are up-and-down records for R.W.G.H. for the supine and upright positions respectively. Records in the supine position for the other subjects are not available; for the upright



Up-and-down movement denoted by L; towards the time line corresponds to an upward movement.
Side-to-side movement denoted by S; towards the time line corresponds to a leftward movement.
1 and 2, head movements for W.D.W. and R.S.L. respectively.
3–7, eye records for W.D.W., R.S.L., R.W.G.H., L.C.T. and M.P.L. respectively.
Time (increasing to right) marked by dots, 50 per sec., and by lines at 1/5 sec. intervals.
Amplitude shown at side: height of arrowed line represents a rotation of 20′, assuming the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5·3 mm.

position, their average intervals between flicks are 0·94, 5·2, 5·3 and 12 sec. for R.N.W., L.C.T., P.B.W. and R.S.L. respectively. The posture change has little effect on the duration (0·02–0·03 sec.) and magnitude (2–25′) of the flicks. The frequency and character of the blinks (for example, *B*, Fig. 3*L*) are apparently unaffected by the alteration of the subject's position.

The increase in the magnitude of the head movements on sitting up is in accordance with earlier observations[3], and is not surprising in view of the fact that greater muscle tone is associated with the upright than with the supine position. Moreover, for the sitting-up position, the head was not supported at the back as it was in the supine case ; it is therefore the more difficult to understand why, in the upright position, the greatest displacement occurs sideways. That a change of posture should have an effect on the eye movements is to be expected ; for the extra-ocular muscle tensions are influenced by labyrinth impulses and the stimulation of the otoliths is different for the supine and upright positions. It is not immediately obvious why, in the case of R.W.G.H., change in posture has no marked effect.

I am very grateful to Dr. W. D. Wright and Mr. R. S. Longhurst for recording my observations and for acting as subjects ; I wish to express my thanks also to the other subjects : Dr. L. C. Thomson and Messrs. R. W. G. Hunt, P. B. Watt and R. N. Wilson. I gratefully acknowledge the continued financial support of the Medical Research Council.

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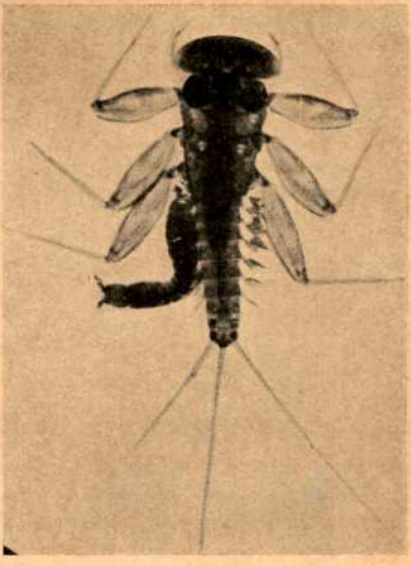
Phoretic Association between *Afronurus* and *Simulium* Species, and the Discovery of the Early Stages of *Simulium neavei* on Freshwater Crabs

DURING the course of routine sampling of the gravel bottom fauna of the Sagana River (Kenya Colony), at an altitude of 5,865 ft. in connexion with fishery research on trout foods, it was noticed in 1948 that many nymphs of the ephemeropteran *Afronurus peringueyi* (E.-P.) had *Simulium* larvæ and pupæ attached to their backs. Examination of these pupæ by one of us (J. McM.) showed that they were of a species not hitherto described ; and this species is not apparently found anywhere else in the river. 49 per cent of all *Afronurus* collected from all parts of the river between 5,900 and 5,600 ft. were found to have *Simulium* larvæ attached ; pupæ are much more scarce.

The *Simulium* larvæ are always found in the same position, attached by the anal sucker to the side of the ephemerid nymph just at the base of the coxa of the hind leg, either on the right or left side. In captivity, the *Simulium* larvæ have been seen to move over the surface of the nymph in the typical 'looping' fashion ; but they always come to rest in the position described with the head and body pointing backwards over the gills of the nymph (see photograph). Pupation occurs on the dorsum of the nymphal thorax, with the pupal filaments pointing backwards over the body of the host.



Living *Afronurus peringueyi* nymph, with *Simulium* sp. larva attached. × 9

It proved difficult in the laboratory to rear this interesting association ; but adults of the *Simulium* species have now been bred out and will be described elsewhere. A most interesting feature of this association, which appears to be a phoresis, is the mutual timing of the various nymphal and larval stages. During the moults of the *Afronurus* nymph, accomplished in the usual manner by splitting along the dorsum, the *Simulium* larva may become detached for a short while until the moult is complete, and then re-attaches itself to the newly moulted nymph in the same position ; or alternatively, the *Simulium* larva remains attached to the old nymphal skin, and then transfers itself to the newly moulted nymph when the moult is almost complete.

The *Simulium* larva always pupates after the *Afronurus* has completed its last nymphal moult ; when the eclosion of the *Afronurus* sub-imago takes place, and the nymphal skin is finally cast off, the *Simulium* adult also emerges from the pupa. The emergence of both adults takes place in the hours of darkness within an interval of one or two hours. The ovipositing habit of the adult *Simulium* is not known.

The adults of this *Simulium* species which have been bred are so remarkably like the adults of *S. neavei*, the vector of onchocerciasis in the western parts of Kenya Colony, that they may easily be mistaken for it at first glance. Minor differences are, however, apparent, and no true *S. neavei* adults have been caught in the vicinity of the Sagana River. The resemblance, however, is so close that it immediately suggested that the early stages of *S. neavei*, hitherto undiscovered in spite of intensive searches in Kenya and elsewhere, might be found to have this unsuspected habit also.

It was known that *S. neavei* could be eliminated from an infested area by dosing the rivers and streams with DDT emulsion, a fact indicating that the early stages were to be found in such rivers and streams. One of us (J. McM.) therefore proceeded to Ngoina, near Kericho (Kenya Colony), in February 1950 in order to carry out further investigations. This area is a focus of onchocerciasis, and *S. neavei* adults are very numerous.

Catches made over a period of years indicated that *S. neavei* adults seem to prefer to live near the smaller rivers and streams, and accordingly work was begun on a small river passing through heavily wooded country, and having many small cascades and waterfalls in its course. Large numbers of the younger stages of various insects, as well as crabs and fish, were examined during a period of two weeks for evidence of such an association, with negative results. However, searches in two of the larger rivers, the Kipsonoi and the Sondu, soon produced evidence that there is a definite association between freshwater crabs (*Potamonautes* (*Potamon*) sp.) and a *Simulium* sp. As many as ten larvæ have been found attached to the carapace of one crab, and the maximum number of pupæ observed was three. Adults bred from these pupæ appear to be *S. neavei*, and the male and pupa will be described in detail at a later date; the pupal respiratory organ has eight long slender breathing filaments, equal in length to the cocoon. The female has already been described by Roubaud.

The association between crabs and this *Simulium* species coincides with the distribution of *S. neavei* adults, whereas that between *Afronurus* and *Simulium* species seems to occur at a higher altitude well outside the *S. neavei* belts. Only one specimen of *Afronurus* collected in the Kipsonoi was found to have a pupa attached, and not more than twelve were collected in the Sondu during a period of six days; but in the higher Kiptiket River, 20 miles away and some 300 ft. higher, twenty nymphs with pupæ attached were collected during a period of two hours.

The crabs concerned seem to prefer to live in the rockier parts of the rivers, such as cascades, and no specimens have yet been caught on mud or other soft river-bed material.

Simulium–Afronurus associations have now been found in several Kenya rivers, and the whole problem is still the subject of study in all its aspects. Dr. G. Marlier, of I.R.S.A.C., Belgian Congo, has informed one of us (V. D. v. S.) *in litt.* that he has found similar *Simulium–Afronurus* associations in rivers in the Kivu Province of the Congo, apparently two species of *Simulium* being involved; Dr. Marlier is publishing a note on this subject elsewhere.

In conclusion, we wish to thank Mr. Hugh Copley, fishwarden, Kenya Colony, and Dr. T. Farnworth Anderson, director of Medical Services, Kenya Colony, respectively, for permission to publish this joint note.

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Sulphamic Acid as a Test for Nitrate-reducing Bacteria

SULPHAMIC acid (aminosulphonic acid) decomposes nitrites quantitatively[1] with evolution of nitrogen gas according to the equation

$$NH_2.SO_3H + MeNO_2 \rightarrow MeHSO_4 + H_2O + N_2.$$

The reaction, which is very specific and strongly catalysed by hydrogen ions, may be used for the removal of interfering nitrites, for example, when testing for nitrates[2], or in water analysis as part of the Winkler method for dissolved oxygen determinations, where nitrites will cause serious error unless removed. For this latter purpose, according to Cohen and Ruchhoft[3], sulphamic acid possesses distinct advantages over sodium azide.

It seemed worth while investigating whether sulphamic acid had any value in bacteriology as a reagent for detecting nitrites in the nitrate-reduction test, for which it would appear it has not hitherto been used. Preliminary experiments to ascertain the limits of sensitivity of the reagent were carried out using a solution of sulphamic acid prepared according to the directions of Cohen and Ruchhoft (*loc. cit.*). This is a 4 per cent solution in 20 per cent v/v sulphuric acid. Standard solutions of nitrite were prepared from silver nitrite. The following technique was used. 1 ml. of standard nitrite was pipetted into a small test tube (7·5 cm. long by 8 mm. internal diameter). The tube was slightly inclined and 1 ml. of the sulphamic acid solution was pipetted down the side. By this method water blanks showed no bubble formation. In the test solutions gas bubbles were readily seen in concentrations of nitrite down to 5 p.p.m. (expressed as nitrogen).

One hundred cultures of catalase-positive cocci were tested for nitrate reduction both by the sulphamic acid technique outlined above and also by the usual modification employing the Griess–Ilosva reagents (sulphanilic acid and α-naphthylamine in acetic acid solution). All the cultures were examined by one test before the second test was applied. In this way, the result of one test on an individual culture was not known before applying the second test, thus avoiding any prejudgment of the result. The records showed that in each of the sixty-two cultures in which a positive result was noted with the Griess–Ilosva reagents, evolution of gas was observed with the sulphamic acid solution. No gas bubbles were seen in the remaining cultures.

A full account of the work and a critical survey of the two methods will be published elsewhere.

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Effect of Aspartic Acid on Growth of Plant-Virus Tumour Tissue

RECENTLY several workers have concluded that, under certain conditions, amino-acids can be assimilated intact by yeasts[1,2]. White and Munns[1] conclude that aspartic acid can be used as a source of nitrogen by yeast, and also that the carbon skeleton can be used if fermentable sugars are present (probably as energy sources). They found that when aspartic acid is added to the test medium in sufficient amount, the growth of yeast greatly exceeds that when only hexose sugars are present.

Results of this nature have been found by Nickell and Burkholder[3] working with virus tumour tissue from the sorrel plant (*Rumex acetosa* L.)[4,5] grown *in vitro*. It was found that aspartic acid could serve, to a certain extent, as a carbon source for the growth of this tissue. Nitrate was found to be the best source of nitrogen; but aspartic acid, of all the other organic and inorganic nitrogenous compounds tested, alone approached nitrate in its effectiveness as the sole source of nitrogen. Moreover, when nitrate and sucrose were present in optimal concentrations, and when other environmental and nutritional conditions were optimal[6], the addition of aspartic acid caused a stimulation of growth proportional to the amount added, up to 0·032 *M*. Concentrations higher than this have not been tested. It is apparent that the stimulation of growth caused by aspartic acid in the presence of optimal amounts of carbon (sucrose) and nitrogen (nitrate) is due to some other reason than simply its utilization as a source of carbon or nitrogen or both. It is possible that aspartic acid, so important in the metabolism of many plant tissues, is in the present instance the limiting factor when the other optimal conditions are met. It might be mentioned, also, that when aspartic acid is present in the medium, the colour of the tumour tissue is much greener than when grown under any other conditions, except when starch is utilized as the carbon source. This suggests that aspartic acid may have some effect on the synthesis of chlorophyll in this tissue.

From the results presented above, it is suggested that in this case, too, aspartic acid can be assimilated intact by the tumour tissue.

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In vitro Inhibition of Growth of a Pathogenic Protozoan by a Derivative of Glutamic Acid

DL-N-(gamma-glutamyl)-ethylamine has been found to act as an antimetabolite of glutamic acid in the growth of *Staphylococcus aureus*[1]. The object of the present investigation was to study the influence of this substance on the multiplication of the parasitic flagellate *Trichomonas vaginalis*.

DL-N-(gamma-glutamyl)-ethylamine was prepared, as previously described, from DL-pyrrolidonecarboxylic acid and aqueous ethylamine[2]. *T. vaginalis* was grown in the absence of bacteria according to the method of Adler and Pulvertaft[3]. The medium described by Johnson[4] consists of a solid phase (liver infusion agar slant) and a liquid phase containing sodium chloride, phosphates, proteose peptone, blood serum and penicillin. The cultures were kept at 37° and passages were made every three to four days.

Various proportions of DL-N-(gamma-glutamyl)-ethylamine and L-glutamine were added to tubes containing 6 c.c. of the liquid medium over a liver infusion slant and nine–ten drops of the culture. Parallel experiments were carried out with the same amounts of DL-N-(gamma-glutamyl)-ethylamine and sodium L-glutamate.

TABLE 1. EFFECT OF DL-N-(GAMMA-GLUTAMYL)-ETHYLAMINE ON THE DEVELOPMENT OF *T. vaginalis*

DL-N-(γ-glutamyl)-ethylamine	Development of *T. vaginalis* after 96 hr.
50 mgm.	+ + +
100	− − −
100	+ + +
135	− − −
150	− − −

Table 2. EFFECT OF L-GLUTAMINE AND OF SODIUM-L-GLUTAMATE ON INHIBITION OF DEVELOPMENT OF *T. vaginalis* BY DL-N-(GAMMA-GLUTAMYL)-ETHYLAMINE

DL-N-(γ-glutamyl)-ethylamine	L-glutamine	Development of *T. vaginalis* after 96 hr.
150 mgm.	10 mgm.	− − −
,,	20	− − −
,,	30	+ + +
	Sodium-L-glutamate	
150 mgm.	30 mgm.	− − −
	60	− − −
0"	,,	+ + +

As shown in Table 1, 135 mgm. of DL-N-(gamma-glutamyl)-ethylamine completely inhibited the multiplication of *T. vaginalis*, whereas 100 mgm. inhibited the growth occasionally. Table 2 shows that this inhibition is reversed by the addition of 30 mgm. of L-glutamine; while twice this amount of sodium-L-glutamate was without effect.

These results seem to indicate that in *T. vaginalis* DL-N-(gamma-glutamyl)-ethylamine acts as a competitive antagonist of glutamine rather than of glutamic acid, and that glutamine is obligatory for the development of a culture of *T. vaginalis*.

It was found necessary to use relatively high concentrations of the antagonist, probably because blood serum and liver infusion contain relatively high concentrations of glutamine[5]. Moreover, the varying results obtained with smaller amounts of the antagonist could be explained as due to variations in the concentration of glutamine in the media employed.

We are indebted to Prof. S. Adler, of the Department of Parasitology, Hebrew University, for providing the strain of *Trichomonas vaginalis* employed in this work.

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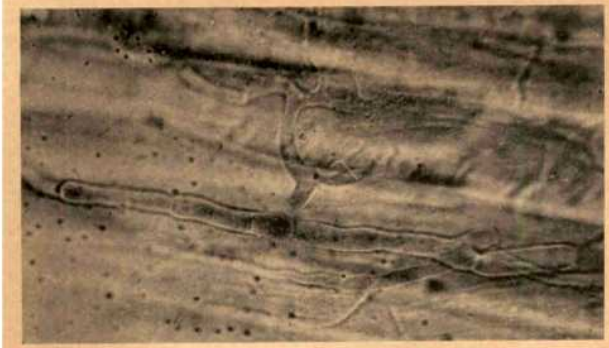
Problem of Wheat-Rust

PROF. STAKMAN in the United States, by continual breeding of resistant strains of wheat and by application of effective spraying at the appropriate time, has been able to minimize loss by rust; but in spite of his devoted labours for more than three decades and the ample facilities given by the U.S. Government, he has not been able to eradicate the wheat-rust from the country.

Examination of some samples of fresh and healthy Indian wheat seeds of this year showed the invariable presence of distinctly septate and branched fungal hyphæ in the subepidermal region of the seeds, just



Hyphæ of *Alternaria* sp. within the seed-coat of Indian wheat. (× 700)

beneath the testa within the tegmen of the grains (see Fig.), when the epidermis was stripped whole from such grains and stained with aniline blue. Aseptic culture from some such seed grains gave rise to *Alternaria* sp. in potato dextrose agar and malt agar tubes. When these grains germinated within the culture tubes, sections of the plumules and radicles showed the same septate and branched hyphæ within their tissues, which in pure culture produced *Alternaria* spores. Canadian wheats, recently received through the courtesy of Dr. W. F. Hanna of the Rust Research Laboratory of Winnipeg, when sectioned, showed the same septate hyphæ in the subepidermal region of wheats. Repeated isolation of mycelium of *Alternaria* sp. from surface-sterilized seeds indicated that the fungus remained within the seed tissues. Hanna Schwarz-Kraepalin[1], on examination of three hundred grains of wheat from different sources, always found fungal hyphæ on the inner side of the skin; she also found such internal fungus in rye, spelt, barley and oats. T. A. Oxley[2], in his attempt to obtain fungus-free wheat grains, found subepidermal fungus in several samples of 'Bersee' wheat. Whitehead *et al.*[3] isolated *Microascus trigonosporus* from surface-sterilized seeds of wheat; they hold that the "fungus persists within the enveloping tissues in dormant seeds of several crop plants with no apparent damage to host development", and their inoculation experiments gave no evidence of definite necrosis or reduced vigour of the treated plants.

It would be worth while to follow the growth of these internal fungi within wheat plants in an aseptic glass-house under controlled conditions, and to bring out the relationship, if any, between them and the external rust-producing fungus, *Puccinia graminis*, and finally to find out if the production of resistant or susceptible strains of wheat depends on the behaviour of these internal fungi. It is my experience in the course of my study of hereditary symbiosis in *Casuarina equisetifolia*[4] that some fungi act under certain environmental conditions as beneficial agents to hosts; under other conditions they may prove serious enemies.

Because of the great economic importance of wheat-rust, there should be abundant support for research from various angles. I suggest that intensive work should be carried out in all wheat-producing countries of the world to find out if such internal fungi are almost invariable associates of wheat plants. Mehta in 1935 estimated the loss in India due to wheat-rust at about 600 million rupees annually. Control of wheat-rust by the development of resistant wheat varieties has not been successful to date because new hybrids of rust fungi have always been effective against any previously resistant wheat. At present, about two hundred distinct strains of black rust are known, of which nine have been so far reported from India by Mehta; but there is every possibility that there may be other strains in this country which have not been identified as yet.

Further details of the work will be published elsewhere.

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Inhibition of the Growth of *Leuconostoc mesenteroides* by the Toxic Factor from 'Agenized' Zein: Reversal by L-Glutamine

THE crystalline toxic factor originally isolated[1] from zein treated with nitrogen trichloride causes epileptiform fits in certain animals and inhibits the growth of *Leuconostoc mesenteroides* *P*-60 [2]. The subsequent synthesis of the factor from methionine, reported[3] from this laboratory, indicates that it probably has the structure $CH_3.SO(NH).CH_2.CH_2.CH(NH_2)COOH$ which, formally, has some resemblance to that of glutamine.

Glutamine reverses the inhibitory effect of methionine sulphoxide, a close analogue of the toxic factor, on the growth of *Lactobacillus arabinosus*[4] and streptococci[5,6], and we have found that it also nullifies the toxic effect of the factor on *Leuconostoc mesenteroides*. Some typical data are given in the accompanying table. The toxic effect of the factor is apparently not specifically dependent on the groupings around the sulphur atom, as the lower homologue, $CH_3.SO(NH).CH_2.CH(NH_2)COOH$, synthesized from L-cysteine by our colleagues Dr. H. R. Bentley and and Mr. J. K. Whitehead, is ineffective at comparable concentrations.

These results may be of interest in relation to the neurotoxic properties of the crystalline toxic factor from 'agenized' zein. The significance of glutamine

ACID PRODUCTION (17 HR. AT 37° C.) BY *Leuconostoc mesenteroides*, ON A FULL-GROWTH MEDIUM: EFFECT OF ADDITION OF TOXIC FACTOR AND L-GLUTAMINE

Crystalline factor ($C_5H_{12}N_2O_3S$) from 'agenized' zein. Concentration $M \times 10^{-4}$	Crystalline factor ($C_5H_{12}N_2O_3S$) synthesized from L-methionine. Concentration $M \times 10^{-4}$	Lower homologue ($C_4H_{10}N_2O_3S$) synthesized from L-cysteine. Concentration $M \times 10^{-4}$	L-Glutamine Concentration $M \times 10^{-4}$	Acid production. Mean titre (ml. of 0·01 *N* NaOH)
0	0	0	0	2·2
3·7	0	0	0	0·55
3·7	0	0	8·5	2·0
3·7	0	0	17	2·2
3·7	0	0	34	2·2
0	0	0	0	2·5
0	3·0	0	0	0·45
0	3·0	0	17	1·95
0	3·0	0	34	2·4
0	0	18	0	2·25

as a metabolite in nerve tissue has been reviewed by Archibald[7], and Waelsch and co-workers have demonstrated[8,9] the alleviating effect of L-glutamic acid in cases of *petit mal* epilepsy.

We are greatly indebted to Prof. F. E. King for a gift of L-glutamine.

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Use of Spores Labelled with Radiophosphorus in the Study of the Respiratory Retention of Aerosols

IN the study of respiratory infection it is important to determine the extent to which an aerosol is retained and the distribution of the retained particles. Retention has been studied, usually with inhomogeneous aerosols of particle-density well in excess of unity, particularly in relation to pneumoconiosis[1]; and viable counts of retained organisms have been made[2]. Difficulties arise in viable counts: disintegration of the head of, for example, a guinea pig and plating out of the resultant slurry is an unsatisfactory procedure, and naturally occurring organisms interfere. (We have found about 10,000 heat-resistant spores in normal guinea pig lungs.)

Distribution of retained aerosols of radioactive materials has been studied by Scott *et al.*[3]. The particle-sizes in this work were too inhomogeneous and the densities far too high to be relevant to bacterial aerosols; but the techniques suggested a most fruitful approach. Various workers have grown bacteria on media containing phosphorus-32 as phosphate: the radiophosphorus is taken into combination as nucleic acids, etc., and the labelled bacteria have been traced after injection[4-8]. For the study of respiratory retention we required a much higher level of induced radioactivity than had previously been used, since various considerations limit the total number of organisms to a comparatively low level.

Extensive studies of resting organisms in high radiation fluxes have been made; but nothing appears to have been published on organisms growing in such conditions. We had, therefore, to determine the highest tolerable activity of medium before studying the use of the active suspensions.

Experimental details. *B. subtilis* was grown on *CCY* agar[9] (less glycerophosphate) containing phosphorus-32 as disodium hydrogen phosphate up to 650 mC./litre. Spores were reaped after 45 hr., heated at 60° C. for 1½ hr., and washed at least six times to remove soluble phosphorus-32 salt. Typical harvests from 30 ml. of agar in an 8 oz. medical flat were:

	a	*b*	*c*	*d*
Radioactivity of medium (mC./litre.)	0	42·5	325	650
Viable spores per flat, × 10^{10}	11·0	6·7	1·6	1·0
Geiger–Müller counts per min., per flat of washed suspension, × 10^7	—	5·2	14·0	21·8
% of added phosphorus-32 utilized by spores	—	15·5	5·5	4·3

Guinea pigs have been exposed to aerosols of single organisms in apparatus used with a Collison spray[10] and to aerosols of larger particle-size generated from a spinning disk[11]. They are killed and the various tissues are digested in nitric acid for assessment.

Counts on suspensions have been carried out with *GM.*2 or *GM.*4 and window counters: *M.*6 liquid counters[12] have been used for aerosol samples collected by impingement in water and tissue digests, and have proved essential to the remarkable speed and simplicity of the experimental technique.

Results. (*a*) *Growth of organisms.* The viable yield on 650 mC./litre. medium is one-tenth that on inactive medium, but the opacity indicates about a quarter of the normal yield; the non-viable spores include a proportion that are seen, using a technique developed by Powell and Pearce[13], to attempt germination but fail to establish colonies (perhaps lethal mutants as discussed by Lea *et al.*[14]). The radiation dosage during growth is about 1·8 × 10^4 rep.; MLD of about 4 × 10^3 rep. for vegetative organisms and 8 × 10^4 rep. for spores are reported[14]. Self-induced dosage in the reaped suspension is roughly estimated at 2 × 10^4 rep. in ten days; the viable count has then fallen to about one-half and continues to decay roughly exponentially.

(*b*) *Exploratory experiments.* Guinea pigs were exposed to aerosols of normal spores, and viable counts were made on disintegrated head, trachea and lungs. Further guinea pigs were exposed to aerosols of radioactive spores, and both viable and radioactive counts were made. These experiments showed that the radioactive measurements were far more convenient and probably gave sufficiently accurate results. Exposure was also made to aerosols of the supernatant fluid from centrifuged radioactive suspensions: this showed that the water-soluble activity (usually less than 5 per cent of the total) did not significantly affect results.

(*c*) *Retention of particles of known size.* Exposures under (*b*) gave information about single organisms (nominally 1 μ particles). An apparatus[11] developed in this Department has now been used for exposure to homogeneous aerosols of 'dry' particle diameter 4–10 μ. Typical results are:

Particle size	No. of guinea pigs	% of total retention in Head	Trachea	Lungs	Trachea and lungs combined
1 μ	6	29	19	52	71
	6	29	13	58	71
	6	29	13	58	71
4 μ	8	65	—	—	35
10 μ	8	98	1	1	2

The total intake of individual guinea pigs in each experiment varies over a range of about 1–3; but the distribution remains remarkably constant.

(*d*) *Miscellaneous observations.* Only the noses of the animals are exposed to the aerosol, but a substantial deposit on the skin is found; it must therefore be carefully removed before digesting the head. Substantial counts are obtained from the stomach in some cases: time-lapse before dissection is obviously important in relation to ciliary removal (*c.* 2 cm./min.).

It is found that spores are strongly adsorbed on glass, which accounts for the loss of viable count from a dilute suspension both when it is stored and when it is agitated by shaking or airsteam. In an experiment with a radioactive suspension the following was found:

Days storage		% of original counts	
		Viable	Radioactive
0		(100)	(100)
1		88	98
2		62	91
3		79	86
4	Tube shaken 10 min.	16	24
	Shaken further 25 min.	13	18

'Manucol' (sodium alginate) suppresses the effect of agitation on viable counts: it also suppresses the drop in radioactive count:

		Geiger–Müller counts			After agitation
		Zero	4 hr.	24 hr.	
'Manucol'	Nil	1,821	1,405	1,248	721
	0·9%	2,044	1,978	1,923	1,935

Since the radioactive count would be unaffected by clumping, the loss must be due to removal of spores from suspension. If the vessel is rinsed with water and then extracted with hot nitric acid, the extract yields most of the missing radioactivity.

We had hoped to trace the exact distribution of retained spores by autoradiographs; but it has proved impossible to achieve anything near the level of activity per spore that is necessary.

The Atomic Energy Research Establishment, Harwell, has supplied the phosphorus-32 and has given valued assistance. The Chief Scientist, Ministry of Supply, agrees to publication of this communication.

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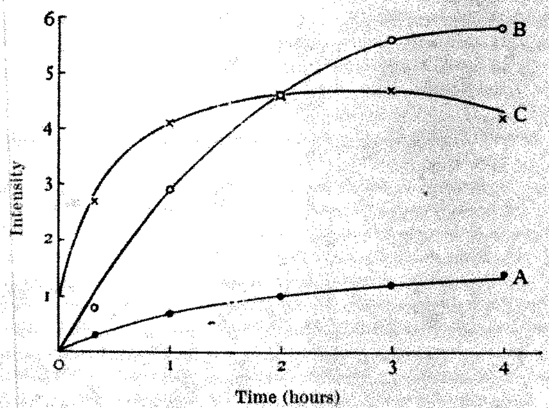
Effects of Histone and other Proteins on the Feulgen Reaction

WHEN deoxyribonucleic acid is subjected to the Feulgen reaction, the pigment which develops may be soluble in water or dilute acid, as the Stedmans[1] have suggested. If deoxyribonucleohistone extracted from nuclei of beef spleen by the method of Mirsky and Pollister[2] is treated in the same manner, the colour develops almost exclusively on the precipitate.

The concentration of hydrochloric acid used was 0·05 *N* throughout the work described here, and the introduction of buffer solutions was purposely avoided. The effects of histone upon the Feulgen reaction not only make the pigment insoluble, but also increase the colour intensity. Highly polymerized deoxyribonucleic acid extracted from beef spleen by the method of Petermann and Lamb[3] was precipitated with an appropriate amount of histone dissolved in dilute hydrochloric acid, the precipitate formed being retained after hydrolysis for three minutes at 100° C. Thymic acid was precipitated with histone from a completely clear solution obtained by the hydrolysis of deoxyrobonucleic acid. It was found that an addition of histone at any time in the course of the Feulgen reaction increased the intensity of the reaction very remarkably. When equal amounts of histone and deoxyribonucleic acid were mixed before hydrolysis, the colour developed almost exclusively in the precipitate. With smaller amount of histone, the precipitation of the dye was incomplete and the enhancement of the colour intensity was less prominent, while addition of an excess of histone made the precipitate soluble again, so that the intensity of the reaction could easily be determined as follows. To each of 0·5 ml. of a 0·1 per cent solution of deoxyribonucleic acid were added (*a*) 4 ml. of hydrochloric acid and (*b*) 4 ml. of a 0·1 per cent solution of histone in hydrochloric acid, and hydrolysis was carried out by heating for three minutes at 100° C. 5 ml. of hydrochloric acid and 0·5 ml. of Feulgen reagent were added to each of these solutions after rapid cooling. The colour developed was compared at intervals with an arbitrary standard, of which the colour had been stabilized by standing more than forty-eight hours. The results are shown in the accompanying graph.

This remarkable colour-enhancing effect is, however, by no means confined to histone, for proteins such as egg albumin, casein, ribonuclease and also lanthanum chloride exhibit similar properties to some extent. Therefore, it seems very probable that the 'adsorption' of the dye is confined not only to chromosomin, as postulated by the Stedmans[1], but is also



A, Without histone; *B*, with histone; *C*, ratio of *B* to *A* shown by proteins in general. Although the nature of the effect described here is not understood at present, it is evident that for the enhancement of the reaction the pigment formed need not be precipitated.

In this connexion it is noteworthy that microscopic sections exert similar effects on the Feulgen reaction, probably because of their protein nature, and results have been obtained comparable with the "developed nucleal stain" of Choudhuri[4]. However, sections treated with hydrolysed deoxyribonucleic acid plus Feulgen reagent and washed exhaustively exhibit an over-all violet coloration, and chromosomes stain by no means selectively, as Danielli[5] has already pointed out. According to my observations, mammalian red cells stain by this procedure most strongly.

Experiments to determine the conditions affecting the intensity of the Feulgen reaction are in progress.

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Biological Detoxication of 2,4-Dichlorophenoxyacetic Acid in Soils: Isolation of an Effective Organism

IN a recent paper[1], evidence was presented to support the view that the detoxication of the selective herbicide, 2,4-dichlorophenoxyacetic acid in soil was due almost entirely to the action of microorganisms. The evidence from this and other similar confirmatory work is entirely indirect, and attempts were therefore made to isolate the organism or organisms concerned.

The method employed was to make, on plates of basal medium[2] containing 0·1 per cent of sodium 2,4-dichlorophenoxyacetate, smear inoculations with drops of perfusate from soils enriched in the relevant organisms by the Lees and Quastel perfusion technique[3,4]. The plates were incubated at 25° C. for seven to ten days, when uniform translucent colonies, apparently of a single species of bacterium, appeared with occasional fungal contaminants. Pure cultures of the organisms were established with little difficulty on the same medium and have been subcultured at fortnightly intervals for the last five months. Repeated attempts to subculture the organism on the basal agar medium alone without sodium 2,4-dichlorophenoxyacetate have so far failed, and it seems likely, therefore, that it is using this compound as its sole source of carbon.

That this organism is the one concerned in the breakdown in the soil is supported by inoculation experiments on soil. The garden soil which has so far been used requires from fourteen to twenty-eight days of continuous perfusion with 0·01 per cent sodium 2,4-dichlorophenoxyacetate solution before an enrichment population capable of the maximum rate of breakdown (that is, 0·01 mgm./gm. dry weight soil/hr.) can be established. If, however, the perfusing solution is first inoculated with a suspension of the organism, the maximum rate is rapidly attained, namely, during the first day's perfusion. So far, the organism has resisted all attempts to grow it in liquid culture of the basal medium containing sodium 2,4-dichlorophenoxyacetate alone; but it will grow readily if small traces of agar (0·1 per cent) are added, suggesting the existence of a necessary growth factor in the agar used. Such a growth factor must also be present in the soil. On the other hand, a heavy suspension of the organisms in aerated basal medium will readily break down the sodium 2,4-dichlorophenoxyacetate in the absence of agar.

The bacterium forms large smooth translucent colonies of a dull cream colour, and is a Gram-negative rod of irregular shape and size with Gram-positive granules. Its growth, fermentation reactions, etc., have been tested on the usual differentiating media, and it has thereby been shown to belong to the very common soil organisms of the "*Bacterium globiforme* group" of Lochhead and Taylor[5]. The type organism of the group was originally isolated and described by Conn[6]. The fact that the organism decomposing sodium 2,4-dichlorophenoxyacetate belongs to such a group of very common and prolific soil bacteria opens up a wide field for speculation. The nature of the normal carbon substrate for organisms of the *B. globiforme* group is still largely a matter for conjecture; but the kinetics of breakdown of 2,4-dichlorophenoxyacetic acid in soil, showing a long initial lag phase, suggest that this molecule is not attacked by the normal soil *B. globiforme* flora. The ultimate rapid attack on the molecule is therefore most likely to be accounted for either by the selective proliferation of a mutant endowed with suitable enzyme systems, or by the adaptive development of such enzymes in normal soil species. So far, very few perfusates of enriched soils have been examined in this way, and it is not improbable that other species of organism, also capable of decomposing 2,4-dichlorophenoxyacetic acid, may be isolated in due course. Full details of this work will be published later.

My thanks are due to Dr. W. T. Williams and to Mr. G. S. Spencer for their help in the identification of the organism.

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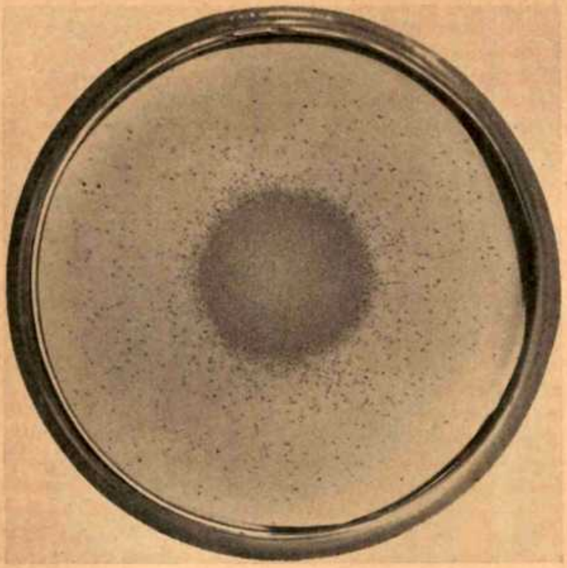
An Antagonist of Dihydrostreptomycin and Streptomycin Produced by *Pseudomonas pyocyanea*

DIFFICULTY arises in testing the sterility of dihydrostreptomycin preparations because there are no antagonists which will inactivate the antibiotic in the test cultures, and so allow any contaminating microbes to grow. The reagents used for inactivating streptomycin in such tests, for example, semicarbazide and hydroxylamine, are inactive against dihydrostreptomycin, because the aldehyde group with which they react has been reduced. Moreover, these reagents, being themselves bacteriostatic, are, in fact, unsatisfactory for testing streptomycin, since some



Growth of *B. subtilis* on plate of nutrient agar containing dihydrostreptomycin, occurring in a zone where the dihydrostreptomycin was antagonized by the previous growth of *Pseudomonas pyocyanea*. Slight inhibition of growth in the centre of the zone is due to antibiotics produced by the *Pseudomonas pyocyanea*

contaminating organisms may fail to develop in the presence of the high concentrations necessary to inactivate concentrated solutions of streptomycin[1]. A search was therefore made for agents active against both streptomycin and dihydrostreptomycin. Soyabean lipositol, which has been reported to inhibit streptomycin[2], was found to be inactive against both streptomycin and dihydrostreptomycin. Hydrolysis of the glycosidic linkage by the action of an enzyme preparation from snail gut was tried without success. The production of a streptomycinase by *Pseudomonas pyocyanea* was reported by Sureau *et al.*[3]. A culture filtrate of a strain of this bacterium antagonized streptomycin and dihydrostreptomycin. The active principle in the filtrate diffused through 'Cellophane' and was heat stable, and was not, therefore, an enzyme.

A rapid method of demonstrating streptomycin and dihydrostreptomycin inhibitors in bacterial cultures was devised. Nutrient agar plates are prepared containing dihydrostreptomycin in a concentration that will just inhibit growth of the indicator organism added later. Sterile 'Cellophane' disks are laid on the surface of the agar, and the strain under test seeded on to the centre of the 'Cellophane'. After 24 hr. incubation at 37°, the 'Cellophane' and the bacterial colony are removed and the plate then covered with a layer of nutrient agar seeded with indicator organism, for example, *B. subtilis* spores or *Staph. aureus*. The plate is incubated at 37° C. for 24 hr. and the production of antagonists that have diffused through the 'Cellophane' is shown by the presence of colonies of the indicator organism in the upper agar layer (see illustration).

By incorporating both antibiotic and indicator organism in the nutrient agar, the antagonistic power of culture filtrates can be assayed by a cup plate method using a single incubation of 24 hr. The diameter of the zone of growth around the cup is proportional to the logarithm of the concentration of antagonist. When the culture filtrate contains also an antibiotic, for example, pyocyanin, a zone of inhibition is seen inside the zone of growth.

Chromatograms of concentrated extracts of culture filtrates can be developed on filter paper strips using a mixture of butanol and acetic acid. The position of the antagonist on the strips may be shown as a discrete zone by laying the strips on the surface of a large assay tray containing nutrient agar prepared as for assays, and incubating at 37° C.

This appears to be the first instance of an antagonist active against both streptomycin and dihydrostreptomycin, and it is possible that the identification of the factor responsible may lead to a better understanding of the mode of action of these antibiotics. The antagonist is formed during the growth of *Pseudomonas pyocyanea* in a chemically defined, as well as in ordinary, culture medium. It is soluble in fat solvents and stable to acid and alkali. Its activity is markedly affected by the *p*H of the test medium, decreasing with increase in *p*H. Its properties are being examined.

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National Institute for Medical Research,
Mill Hill,
London, N.W.7.
June 12.

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[2] Rhymer, I., Wallace, G. I., Byers, L. W., and Carter, H. E., *J. Biol. Chem.*, **169**, 457 (1947).

[3] Sureau, B., Arquie, E., Boyer, F., and Saviard, M., *Ann. Inst. Pasteur*, **75**, 169 (1948).

Crystal Structure of $[\mathrm{Cu(en)_2}][\mathrm{Hg(SCN)_4}]$

CRYSTALS of the compound $[\mathrm{Cu(en)_2}][\mathrm{Hg(SCN)_4}]$ were kindly supplied by the Chemistry Department of Birkbeck College and an X-ray investigation was carried out to determine its complete crystal structure. The complex $\mathrm{Co[Hg(CNS)_4]}$ has already been subject to X-ray investigation[1], showing that as these crystals were tetragonal with space group $I\bar{4}$ there was good evidence that the thiocyanate groups would be tetrahedrally situated about the mercury atom. A study of the copper diethylenediamine complex has revealed that although the sulphurs of the thiocyanates were still tetrahedrally co-ordinated to the mercury atom, the presence of the $\mathrm{Cu(en)_2}$ was now sufficient to destroy the tetrahedral arrangement of the remainder of the thiocyanate groups with respect to the mercury atom, thus indicating that there is a flexibility of the —SCN group arising out of a rotation of the group about the Hg—S bond; this flexibility depends on the arrangement of the neighbouring groups. In cases where the surroundings of the $\mathrm{Hg(SCN)_4}$ are symmetrically situated about it, as in the $\mathrm{Co[Hg(SCN)_4]}$ complex, the thiocyanate groups can take positions compatible with the external symmetry of the crystal. On the other hand, if there is no symmetry around the $\mathrm{Hg(SCN)_4}$ complex, this being the case of the $[\mathrm{Cu(en)_2}][\mathrm{Hg(SCN)_4}]$, the thiocyanates take up unsymmetrical positions satisfying the structural features of geometrical packing and charge neutralization. This may explain why these crystals occur in a system of lower symmetry.

The crystals, of a deep purple colour, are monoclinic, well-developed prismatic plates with $\{010\}$ dominating. The optics give a positive sign with γ parallel to the *b*-axis and β lying at about 24° to the *c*-axis in the obtuse angle. Dichroism is observed on $\{010\}$.

The cell dimensions are: $a = 7 \cdot 51$ A., $b = 18 \cdot 03$ A., $c = 14 \cdot 20$ A., $\beta = 96° \, 32'$. The space group is $P2_1/c$

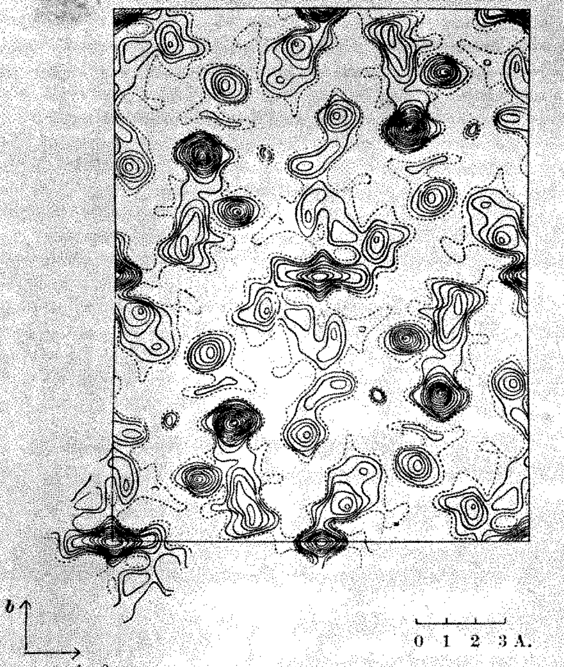

Fig. 1. Electron density map on the plane normal to the a-axis

and the measured density, 2·127 gm./c.c., gives four molecules per unit cell containing four units of Cu(en)$_2$ and Hg(SCN)$_4$.

The following steps were carried out. (1) From Patterson analysis on the three main projections the co-ordinates of the mercury and copper atoms were obtained. The mercury atoms lie in general positions, while the copper atoms are found at the centres of symmetry $\frac{1}{2}00$, $\frac{1}{2}\frac{1}{2}\frac{1}{2}$; $\frac{1}{2}0\frac{1}{2}$, $\frac{1}{2}\frac{1}{2}0$. (2) Using the phase contribution of these heavy atoms for all three projections, it was possible to locate the sulphur atoms. (3) The positions of the lighter (carbon and nitrogen) atoms of both the thiocyanate and ethylenediamine groups had to be obtained from three-dimensional Fourier synthesis using the phase contributions of the mercury, copper and the four sulphur atoms.

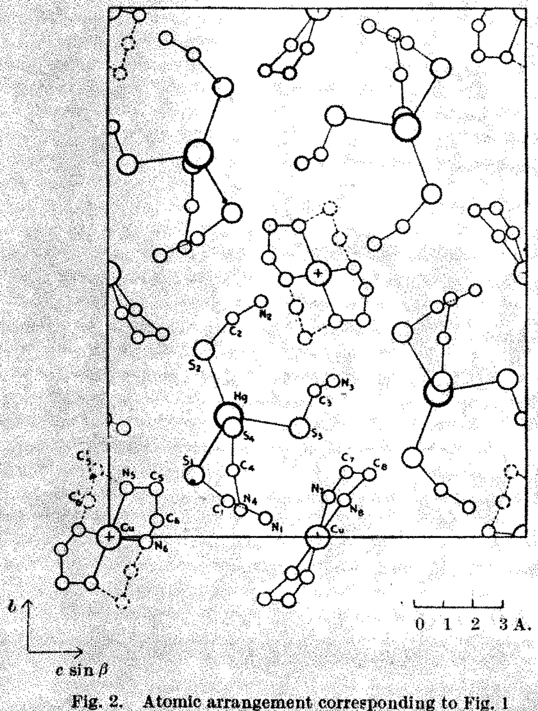

Fig. 2. Atomic arrangement corresponding to Fig. 1

From Fourier sections parallel to the three axes, it was possible to confirm that: (a) the four sulphur atoms are tetrahedrally arranged about the mercury atom at a mean distance of 2·56 A. and with a mean S—Hg—S angle of 109° 16′; (b) the thiocyanate groups appear to be kinked; this was confirmed independently for individual groups. It should be pointed out that the analysis is incapable of deciding unequivocally whether the group is S—C—N or S—N—C; but for the moment chemical evidence suggests that it is probably S—C—N, and this had been tentatively accepted. The S—C—N angle has a mean value of 156° 24′ and the mean S—C and C—N distances were found to be 1·57 A. and 1·33 A. respectively. (c) The amino-nitrogens of the ethylenediamine groups are bonded to the copper atoms forming five-membered rings. It is found that the Cu(en)-rings are non-planar, and there is also strong evidence of two possible stereochemical configurations for these ring systems which is being investigated at the moment.

It was, in addition, found that two nitrogens of the thiocyanate groups are co-ordinated to the copper atoms, thus giving it a six-fold co-ordination. Fig. 1 is a Fourier projection of the electron density on a plane normal to the a-axis based on the phase contribution of Hg(SCN)$_4$ and Cu. The atomic positions marked on Fig. 2 are those obtained from the sections.

A detailed description of the work will appear elsewhere.

One of us (H. S.) is indebted to the British Council for a maintenance grant which enabled her to undertake this work.

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April 28.

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[1] Jeffery, J. W., *Nature*, **159**, 610 (1947).

The Reactions Leading to the Sodium *D*-Line Radiation in Flames

IN a recent communication[1] by one of us, substantial evidence was given of the suppression of the *D*-line sodium radiation in hydrogen flames by additives—such as carbon dioxide and other polyatomic molecules—which likewise inhibit the chemiluminescence of manganese-promoted calcium oxide in contact with the flames. It was considered that the effect of the additive was greatly to reduce the concentration of hydrogen atoms, the presence of which is necessary for the chemiluminescent effect referred to.

The suppression of the *D*-line does not arise from the inability of sodium salts to vaporize when the additives are present. This can readily be shown by bringing near the colourless flame a second flame in which hydrogen is burning at a carefully cleaned quartz tip. At the meeting point of the two flames an intense *D*-line is given, indicating that abundant molecules of sodium salts are available in the former.

Since the measurement of flame temperatures by the *D*-line reversal method generally gives quite reasonable results[2,3] (so long as the gas through which the incident radiation passes is at fairly uniform temperature) the excitation is unlikely to be a chemiluminescent effect in these cases. Since it is equally unlikely that hydrogen atoms assist in the quenching of excited sodium, we consider that the part played by the hydrogen atoms is to cause the formation of free sodium atoms from its salt according to the equation

$$\text{Na}X + \text{H} \rightarrow \text{H}X + \text{Na}.$$

If X is halogen, this reaction is nearly thermally neutral, the heat evolved being 4·4 k.cal. for the chloride, − 5·3 k.cal. for the bromide, and − 8·3 k.cal. for the iodide. In contrast, the dissociation reactions of the type $\text{Na}X \rightarrow \text{Na} + X$ are strongly endothermic, the dissociation energy being greatest in the case of the chloride (97·7 k.cal.) and smallest in that of the iodide (71·7 k.cal.[4]).

Since the line-reversal method for measuring gas temperatures is essentially a null method, it will be clear that the explanation given fully accords with the facts, namely, that the intensity of the line is a function of the hydrogen-atom concentration (and the nature of the sodium salt) and the reversal point a function of the ambient temperature.

J. R. Arthur
D. H. Bangham
R. H. Baulk
G. Whittingham

British Coal Utilisation Research Association,
Leatherhead, Surrey.
June 5.

[1] Arthur, J. R., *Nature*, **165**, 557 (1950).

[2] Kohn, H., *Ann. Physik.*, **44**, 749 (1914).

[3] Lewis, B., and Von Elbe, G., "Combustion Flames and Explosions of Gases", 329 (Cambridge, 1938).

[4] Gaydon, A. G., "Dissociation Energies and Spectra of Diatomic Molecules" (London, 1947).

The Meyer Law for Hardness Tests

The indentation test, made by forcing an undeformable ball into the test piece, of which the Brinell test is the most extended form, is governed by an empirical relation between load and diameter, $P = a\,d^n$, due to Meyer.

The constants a and n are frequently employed for estimating strain-hardening, since a increases, while n decreases with work-hardening. The law can be checked and a new meaning can be given to these constants, starting from classical laws of elasticity.

According to Hertz[1], the depth of the indentation or its diameter is given by

$$h = \frac{9}{64}\left(\frac{1-\nu}{G}\right)^2 \frac{P^2}{R}$$

$$d^3 = 3\left(\frac{1-\nu}{G}\right) P.R,$$

where G is the modulus of rigidity and ν the reciprocal of Poisson's ratio. If Young's modulus is used, the second equation becomes :

$$d^3 = \frac{3(1-\nu^2)}{E} P.D, \qquad (1)$$

where D is the ball diameter. Therefore, in the elastic range, Meyer hardness number is easily seen to be

$$H_M = \frac{4P}{\pi d^2} = \frac{4E}{3\pi(1-\nu^2)} \frac{d}{D}. \qquad (2)$$

Poeschl[2] suggested that this equation could be employed in the plastic range, maintaining the formal similarity, but replacing the constant E by an empirical value obtained experimentally, in the plastic range, by an indentation test. Replacing Young's modulus E by an instantaneous plastic modulus π, we have found that its rate of variation with increasing strain is of the form :

$$\pi = E\left(\frac{d_0}{d}\right)^\eta, \qquad (3)$$

so that π represents the above-mentioned modulus of plasticity and d_0 and η are constants. The equation has been tested within the range of values $0{\cdot}1 < d/D < 0{\cdot}7$, and it has been proved correct whatever the ball diameter. Going beyond lower values $d/D = 0{\cdot}1$, the modulus π should increase, approaching E. This assumption enables us to establish an indentation elastic point, the impression diameter of which would be d_0.

Substituting (3) in $P = \dfrac{\pi}{3(1-\nu^2)} \dfrac{d^3}{D}$ gives

$$P = \frac{E.d_0^\eta}{3(1-\nu^2)D} . d^{3-\eta} ; \qquad (4)$$

therefore, the constants of the Meyer Law are

$$a = \frac{E.d_0^\eta}{3(1-\nu^2)D} \quad \text{and} \quad n = 3 - \eta.$$

By adopting, provisionally, values for E determined in homogeneous compression tests, taking $\nu = 0{\cdot}3$ and extending logarithmic diagrams, $\log \pi = f[\log d/D]$, down to $\pi = E$, and reading, then, the value of d_0/D, it is possible to compute a and n. From the accompanying table, it can be seen that the calculated values are consistent with the experimental ones.

Material	$E.10^{-3}$	Mean values from 2-, 5-, 5- and 10-mm. diameter balls		Calculated values (eq. 3)		Elastic limit	
		n	$a.D^{n-2}$	n	$a.D^{n-2}$	H_0 (kgm./mm.^{2})	Hertzian hardness p_m
Copper	12·7	2·31	52	2·31	50·8	8·45	3·17
70/30-Brass	9·15	2·27	59·9	2·24	61·1	16	6·45
Aluminium (commercial)	7·1	2·33	61	2·31	66·1	13·8	5·2
Soft steel	21	2·36	159	2·37	157	22·3	8·4

From (4) an elastic hardness relationship could also be found :

$$H_0 = \frac{4E}{3\pi(1-\nu^2)} \frac{d_0}{D}.$$

H_0 is the "mean pressure strainless indentation hardness", which represents simply an extrapolation of the Meyer Law. The Hertzian hardness, that is, the maximal pressure on the middle of the impression, is given by :

$$p_m = \frac{E}{2r(1-\nu^2)} \frac{d_0}{D}. \qquad (5)$$

Emilio Jimeno
Jose Terraza

Metallographic Laboratory,
University of Madrid.
March 20.

[1] Lorenz, "Technische Elastizitaetslehre" (Munich, 1913).

[2] Poeschl, *Archiv. Eisenhüt.*, **16**, 425 (1934).

FORTHCOMING EVENTS

Wednesday, August 30—Wednesday, September 6

British Association for the Advancement of Science (at Birmingham).—Annual Meeting.

Wednesday, August 30

(in the Town Hall), at 8.30 p.m.—Sir Harold Hartley, F.R.S.: "Man's Use of Energy" (Presidential Address).

Friday, September 1

(in the Great Hall of the University, Edgbaston), at 8 p.m.—Prof. K. von Frisch: "The Language of Bees".

Sunday, September 3

(in the Great Hall of the University, Edgbaston), at 8 p.m.—Dr. E. W. Barnes, F.R.S., Bishop of Birmingham: "Science, Religion and Moral Judgments".

Monday, September 4

(in the Great Hall of the University, Edgbaston), at 8 p.m.—Dr. A. C. B. Lovell: "The New Science of Radio Astronomy."

Wednesday, August 30—Wednesday, September 6

(in the Department of Mechanical Engineering, The University, Edgbaston), at 10.30 a.m. to 8 p.m.—Exhibition on "Energy in the Service of Man".

Friday, September 1

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Sir Arthur Fleming: "Recent Developments in Engineering."

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant in the Department of Chemistry (to teach Inorganic Chemistry to H.N.C. standard and Analytical Chemistry in the full-time Laboratory Assistants' course), at the Widnes Municipal Technical College—W. R. Wainwright, Education Office, Lugsdale Road, Widnes (September 2).

Lecturer in Chemistry—The Principal, Acton Technical College, High Street, Acton, London, W.3 (September 2).

Mechanical and Aero Engineers and Physicists (Experimental Officer grade, unestablished) at the National Gas Turbine Establishment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.427/50A (September 2).

Officer (with an honours degree in physics, though a general honours degree in physics and mathematics or physics and chemistry would be considered) for scientific work on woollen processing in mills, and in the laboratories—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6 (September 2).

Indexer (with good general knowledge and a degree in science) at the Food Investigation headquarters (Department of Scientific and Industrial Research), Cambridge—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.489/50A (September 4).

Inspector under the Dangerous Drugs Acts in the Home Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 3231 (September 7).

Principal Scientific Officer at the Atomic Energy Research Establishment, Harwell, to take charge of a small group engaged in problems of heat transfer, and special problems arising in the development of nuclear energy for power purposes, etc.—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3235 (September 7).

Lecturer (Grade II) in Pharmacology—The Registrar and Secretary, The University, Bristol (September 14).

Public Relations Officer at the Long Ashton Research Station, Bristol—The Registrar and Secretary, The University, Bristol (September 16).

Lecturer or an Assistant Lecturer in Chemical Engineering—The Registrar, College of Technology, Manchester 1 (September 25).

Physical Chemist to act as deputy head of the Chemistry Laboratories (Ref. TT/237), an experienced Research Physicist to act as deputy head of the Physics Laboratories and to work on the physical properties of coal (Ref. TT/238), Chemists (physical and organic) with experience in metallurgy, distillation, colloid chemistry, surface chemistry or coal tar chemistry (Ref. TT/239), and experienced Research Physicists (Ref. TT/240), at the Central Research Establishment at Stoke Orchard, near Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (September 25).

Chemists I (6), and Chemists II (12) in the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3227 (September 28).

Assistant Director of the Commonwealth Bureau of Dairy Science, at the National Institute for Research in Dairying, Shinfield, Reading—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (October 1).

Lecturer in Geology (to specialize in Petrology and Mineralogy), at the New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 1).

Keeper of the Queen Victoria Museum, Salisbury, Southern Rhodesia—The Director, National Museums of Southern Rhodesia, c/o High Commissioner, Rhodesia House, Strand, London, W.C.2 (December 1).

Professional Engineers in many Departments of the Civil Service—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Srreet, London, W.1, quoting No. 3225 (December 31).

Assistant Biochemist in the Department of Pathology—The Secretary, Royal Infirmary, Bolton.

Assistant Professor or Associate Professor in the Department of Physics—G. M. Shrum, Head of the Department of Physics, University of British Columbia, Vancouver, B.C., Canada.

Assistant Statistician (for work mainly concerned with the analysis of foot dimensions, but will include the statistical treatment of physical and chemical laboratory data)—The Director, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

Entomologist's Assistant (male or female) in the Agricultural Department, Government of Tanganyika—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/23491/3A.

Group Manager of the Ministry of Supply's Capenhurst Factory, Chester, to be responsible for the management of a large chemical engineering plant operating under high vacuum—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Head of the Division of Plant Pathology—The Director, Tea Research Institute of Ceylon, Talawakelle, Ceylon.

Lecturer in the Physics Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

Physical Chemist or Physicist in the Chemical Division, to assist fundamental work on dyes and their solutions—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Professor of Chemistry, and a Lecturer in Botany, at the College of Arts and Science, Baghdad—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

Science Graduate (man or woman) for abstracting technical literature, etc.—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

Scientific Assistant, for information service and abstracting journal—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading, Berks.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Science Museum. Hand List of Short Titles of Current Periodicals in the Science Library. Sixth edition. Pp. iv+282. (London: H.M. Stationery Office, 1950.) 7*s.* 6*d.* net. [47

Wool Industries Research Association. Report of the Proceedings at the Thirty-first Annual General Meeting. Pp. 8. (Leeds: Wool Industries Research Association, 1950.) [47

Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences. No. 613, Vol. 234: The Effects of Entero-Posterior Reversal of Lengths of the Primitive Streak in the Chick. By M. Abercrombie. Pp. 317–338. 9*s.* No. 614, Vol. 234: Structure and Development of the Reproductive System of some Species of Nematocera (Order Diptera: Suborder Nematocera.) By S. E. Abul-Nasr. Pp. 339–396. 13*s.* (London: Cambridge University Press, 1950.) [47

British Welding Research Association. Annual Report, 1949–50. Pp. 50. (London: British Welding Research Association, 1950.) [57

Ministry of Health. Publicity for Local Government; Final Report. Pp. 17. (London: H.M. Stationery Office, 1950.) 6*d.* net. [57

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1949. East Midland Division. Report by W. B. Brown. Pp. ii+24+5 plates. (London: H.M. Stationery Office, 1950.) 1*s.* 3*d.* net. [57

This is the British Glass Industry. Pp. 52. (London: Glass Manufacturers' Association, 1950.) 5*s.* [57

Other Countries

Snellius Expedition in the Eastern Part of the East Indian Archipelago, 1929–1930. Vol. 2: Oceanographic Results, Part 6, Tables; Serial and Bottom Observations, Temperature, Salinity and Density. By P. M. Van Riel, H. C. Hamaker and L. Van Eyck. Pp. v+44. (Leiden: E. J. Brill, 1950.) [57

Colony and Protectorate of Kenya. Catalogue of Kenya Timbers. By S. H. Wimbush. Pp. 69. (Nairobi: Government Printer, 1950.) 2*s.* 6*d.* [57

Research and its Organization. By Dr. Ellice McDonald. Pp. 96. (Newark, Del.: Biochemical Research Foundation, 1950.) [57

Institut Royale des Sciences naturelles de Belgique. Mémoires, Deuxième Série, Fasc. 33: Résultats scientifiques des croissières du Navire-École Belge *Mercator*, Vol. 4, Téléostéens dissymétriques (Heterosomata), par Paul Chabanaud; Méduses, par Gilbert Ranson; Holothuries, par Gustave Cherbonnier; Poissons, par Max Poll. Pp. 269. Mémoires, Deuxième Série, Fasc. 34: Recherches sur la forme et la mécanique de développement des coquilles des Lamellibranches. Par Lucien Lison. Pp. 87. Mémoires, Deuxième Série, Fasc. 35: Contribution à l'étude de la croissance pubertaire de l'homme. Par Dr. François Twiesselmann. Pp. 88. Mémoires, Deuxième Série, Fasc. 36: The African Dorilaidae (Pipunculidae: Diptera.) By D. Elmo Hardy. Pp. 80+6 plates. (Bruxelles: Institut Royale des Sciences naturelles de Belgique, 1949.) [67

Erdöl und Tektonik in Nordwestdeutschland. Sammelband enthaltend die Vorträgen der Erdöltagung in Hannover vom 9 bis 11 September 1947. Unter Mitwirkung zahlreicher Fachgenossen herausgegeben von A. Bentz. Pp. 387+15 plates. (Celle: Amt für Bodenforschung, 1950.) [67

Geologisches Jahrbuch für die Jahre 1943–1948. Herausgegeben von den Geologischen Landesanstalten der Bundesrepublik Deutschland. Band 64. Pp. xxxvi+646+6 plates. (Celle: Amt für Bodenforschung, 1950.) [67

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WORLD RESOURCES OF ENERGY AND THEIR UTILIZATION

ONE of the proposals made by the United Nations Educational, Scientific and Cultural Organisation for bringing the nations together was that certain topics should be selected for world-wide discussion and study each year. For 1950, the year in which the Fourth World Power Conference has met in London, the topic suggested by Unesco was energy in the service of man, and that subject has also been taken as the main theme of the British Association's meeting in Birmingham. An exhibition illustrating this theme has been arranged by the National Coal Board, the British Gas Council and the British Electrical Authority in collaboration with the Birmingham Municipal Museum and the Common Good Fund, while a programme of films on scientific subjects which the British Universities Film Council is presenting will also include films illustrating man's use of energy. Particular aspects of the broad problem, such as civil applications of atomic energy, chemical energy, the gas turbine and agricultural engineering, are engaging the attention of the individual sections of the Association.

The presidential address by Sir Harold Hartley, on man's use of energy (see p. 368 of this issue), is thus both topical and introduces a main theme of the meeting. Fresh from his chairmanship of the World Power Conference and, less than a year earlier, from participation as a British Government delegate at the United Nations Conference at Lake Success on the Conservation and Utilization of Natural Resources, Sir Harold's masterly discourse provides an admirable background for the several discussions and even for other authoritative but specialized addresses like Sir John Cockcroft's Romanes Lecture on the development and future of nuclear energy. Sir Harold's address is, moreover, a most appropriate sequel to Sir John Russell's presidential address last year on world population and world food supplies, and in the sweep of its historical survey alone worthily commemorates the centenary of Clausius's formulation of the Second Law of Thermodynamics, governing the conversion of thermal energy into work useful to man.

It is, in fact, as Sir Harold points out, only a century since man first understood the full import of the word energy and its significance as the driving force of all physical and chemical change and of life itself; yet it has been man's use of energy that has shaped so largely the material progress of the human race. "The story of material progress is man's invention of tools to make his muscular work more effective or to store it and raise its potential, as with the bow and arrow, his invention of machines to multiply his force and ease his tasks, or to repeat them with accuracy independent of the hand or eye. Animals, wind or falling water gave him the energy he needed to multiply his effort. The successive metal ages, copper, bronze and iron, mark man's discoveries of new weapons and machines, and his inventive use of energy in fuels and furnaces to smelt their ores."

Although the birth of modern science in the seventeenth century yielded a fresh understanding of machines and quickened the tempo of invention, for more than two hundred years practice outran theory, in spite of all the great developments which Sir Harold passes in review. Only with the idea of energy and the recognition of its laws a century ago did we pass the great divide in engineering between the old and the new, and enter on what may be termed the age of power production. Starting from the theory of the steam engine, there came a gradual realization of the common driving force behind all physical and chemical changes, and of the laws of energy which govern them. In the hands of Helmholtz, Willard Gibbs, van 't Hoff, Planck and Gilbert Lewis, those laws have become a universal instrument of great power and economic importance in predicting what is possible.

The continuous expansion and the rapid changes in the technical and social pattern of the world in the following century, outlined by Sir Harold in a series of brilliant paragraphs, bring out both the scale of developments and the pace of scientific advance. Not merely were the rapid progress of electricity, of the internal combustion engine and of wireless creating profound changes in the social and technical pattern, but also discoveries like those of Becquerel, Röntgen, J. J. Thomson, Rutherford, Planck and Einstein changed profoundly man's understanding of Nature's processes and at the same time gave him new techniques and new tools for further rapid advance. Nor can the limits to such advance and development yet be predicted.

From this fascinating picture of development and of achievement in raising the standard of human health and comfort, as well as productivity, which Sir Harold unfolds, certain features emerge. First, there is the extent to which the increase in the production of energy has been accompanied by fresh demands for energy. What Sir Harold terms the Domestic Revolution—the scientific application of heat and power in the home—is one example; and the common experience of power 'cuts' in winter may well give point to the question he asks, how long can the world's resources meet these growing demands. Some of them, as in agriculture, have given a new impetus to food production and counterbalanced to some extent the drift of man-power from the land. The availability of energy has also made possible a new partnership between agriculture and industry in the processing of farm products. Canning, refrigeration and deep freezing, air-conditioned transport, crop drying, fermentation processes and the conversion of farm residues into useful products all represent not merely demands for energy, but also the impact of energy on the whole economy of society.

Energy, Sir Harold Hartley commented, is the multiplier of human effort. What has increasingly marked the last half-century, however, is a change in the character of production: human physical effort has been replaced by other powers as the working energy on which the world's production is based. That thesis was elaborated nearly two decades ago in Mr. F. Henderson's "The Economic Consequences of Power Production"; but even now his main point that modern power production embodies a profound and vital change in the relationship of human labour to the products and processes of the world's work is not generally appreciated. Had the significance of this change, and the consequence that human service associated with the machine ceased in its essential character to be labour in the old sense, been fully understood, much industrial friction and loss of production might have been avoided.

That human labour, in the sense in which Mr. Henderson wrote of it, has for the first time in human history ceased to be the measure of output, is a factor which has to be taken into account in considering the increase of productivity in industry and elsewhere. It has its bearings on incentives and problems of leisure as well as on technological unemployment. This is less prominent to-day than when Mr. Henderson wrote; but the maintenance of full employment requires close attention to the mobility of labour, with all its implications, which is here the central issue.

Into such social and economic issues Sir Harold Hartley did not enter; but they clearly cannot be avoided if mankind is to reap the full benefits in the way of leisure and greater abundance and higher standards of living which the increased supplies of energy and this second industrial revolution offer him. Nor can the secondary effects of the wider use of energy be disentangled from social and economic questions. The virtual annihilation of distance, the growing scale of operations and the increased use of power, as Dr. Ellice McDonald pointed out last October, are changing the face of research itself by bringing scientific workers closer together, providing them with ever more powerful instruments and increasing the need for team-work. Despite all the reversals in certain spheres of the past five years, the rapid interchange of persons and ideas has brought the world into a much more closely integrated unit. It has quickened the senses and nerve fibres of nations, and has given them a new awareness of events—a new world consciousness—which in due time must display more fully their inescapable community of interests. Some of the most outstanding achievements of the war years were the outcome of just such international interchange of ideas and persons.

The answer to the question how long the world's resources can meet these growing demands must depend to a large extent on social and economic factors, and that for other reasons than the one given by Mr. Henderson. Sir Harold Hartley, in seeking an answer to the question, notes two important factors. First, reviewing the world's resources of fuel and power, he directs attention to the most unequal distribution of resources between nations. Countries north of latitude 20°, for example, contain 94 per cent of the world's coal reserves and 83 per cent of the oil reserves, while those to the south contain two-thirds of the water-power potential. Energy resources, which must clearly determine the pattern of development of countries, are not the only factor which makes for such differentiation between countries. Deposits of phosphates and potash required for agriculture, while adequate in total for centuries, are most unequally distributed. Reserves of metals, such as copper, zinc, lead and tin are estimated as adequate for some decades only, and here again the distribution of ore deposits emphasizes the inter-dependence of countries. The world sufficiency of energy reserves is, as Sir Harold observes, but a poor consolation for the countries that have few.

The unequal distribution of energy and material resources emphasizes the importance of international co-operation, which is itself conditioned by social and economic factors. Co-operation is the only alternative to international rivalry and tension, and little as Sir Harold says on this point, his experience at Lake Success last year has clearly convinced him of the possibility of effective international co-operation in the conservation and utilization of natural resources. In his Birmingham address he does no more than refer to the importance of transport of power in this connexion. The transmission of electric power over long distances by high-voltage direct current should permit the economic transmission of large blocks of energy for perhaps a thousand miles by underground or submarine cable, thus linking consuming centres with new and distant sources of hydro-electric power. Sir Harold referred also to the possibility of linking the British and European grids, and thus securing a better balance between capacity and requirements by taking advantage of the seasonal variations in capacity and the diversity of demand.

The second factor stressed by Sir Harold is that the major advances have been made in the energy industries. Most modern types of plant have reached a point where only fractional progress is likely to be made and where the limits may be the discovery of new alloys or the higher cost which the gain in efficiency would not justify. There are, it is true, some new developments such as the gas turbine, and limited possibilities in the use of wind power, tides and solar radiation. Discussions at the World Power Conference indicated that the difficulties to be overcome before the use of nuclear energy becomes economical are most formidable, and their solution will require intense effort over a long period. The first use of fissile elements may well be to transport energy to places far remote from other sources.

Accordingly, the world's increasing demands for heat and power are being met largely by improved efficiency and the elimination of waste. In Britain until 1938, the total fuel consumption had been almost unchanged for a quarter of a century; although the population increased by 10 per cent in that period, the use of heat and power in industry was extended and new industries arose. The additional energy required came from the same amount of fuel by increased efficiency of use. Nevertheless, the overall efficiency of use of heat and power in Britain is still probably less than 15 per cent, and there is urgent need for large economies to save the fuel that will be needed for increased production. Sir Harold himself sees in the adoption of automatic control and precision techniques large possibilities of saving in this respect, and in this connexion urges, like Mr. Henderson, that one of the indexes of economic progress should be not the energy used per worker, but the output of goods and services per horse power employed. He rests his hope for the future in part on this more efficient use of the resources of Nature, in part on man's new understanding of the processes of Nature, and in the growing recognition of the dependence of one nation on another.

There once again we are dependent on economic and social factors. Two years ago at Johannesburg, Sir Harold, surveying the limiting factors in world development and the particular contribution of the engineer and man of science, recognized that man is the ultimate limiting factor. So to-day, in this divided world, he suggests that the solution of our present problems of standards of living depends on whether men's minds are bent on the quest of plenty or on the quest of power. On that ultimately depends, for example, whether these resources in the way of transport, of fertilizers, irrigation, heat and power can be brought to meet the needs of the less-developed countries with their ill-nourished millions, with all the benefits which the more advanced countries would in turn reap from such development. Technical assistance to such countries, as Lord Bruce observed in his Messel Memorial Lecture at Newcastle upon Tyne, is primarily a matter of scientific, technical and administrative assistance—in other words, of trained man- and woman-power. It is a question of atmosphere—of the confidence in which co-operation and understanding can grow and men and women give of their best.

"On man's wise use of energy depends so much the future of this troubled world." It is not for us to command the deep wells of unconscious thought, whence wisdom, like creative genius, may issue. But out of the rich experience which has enabled Sir Harold to tell so fascinating a story of the development and use of energy by man, others may draw the inspiration and the resolve which also are needed if we are to match the resources science has put at our command with the opportunities and the needs lying before us.

STORY OF BIRMINGHAM

Birmingham and its Regional Setting

A Scientific Survey. Prepared for the Meeting held in Birmingham, 30th August–6th September 1950. (Published by the Local Executive Committee.) Pp. xix+334. (London: British Association, 1950.)

THE publication this year of the "Scientific Survey of Birmingham and its Regional Setting" follows the usual British Association practice of issuing to its members a scientific survey, prepared by the local committee, of the locality in which the annual meeting of the Association is taking place. This handsomely produced volume, with its wealth of charts and data, compares favourably with the high standard of previous surveys, and the Birmingham local committee is to be congratulated on a job well done.

The book is divided into the following four parts: physical background; evolution of settlement before 1700; the Industrial Revolution; and the modern regional and economic pattern. Within the parts the contents are further subdivided into sections, each of which is a water-tight article on a particular topic, written by an expert (or experts). The main criticism to be levelled against this method is that there is inevitably some overlapping and consequent repetition between the sections. The only other serious complaint which may be made against the Survey is that it has no index.

In the part of the book on the physical background—relief and physiographical regions, geology, geomorphology, climate, soils, vegetation and fauna—the geographical area is wide (rightly so) and includes a large part of the counties of Warwickshire, Staffordshire (South Staffs) and Worcestershire. The geography of Birmingham is not particularly striking; and, as is borne out by the early history of the place, its setting offers no strategic advantages and does not obviously warrant an important city. It is the geological wealth, coupled with the building up of industrial talent, which has made Birmingham the second largest city of England.

We learn that the area shows little trace of Celtic or the superimposed Roman culture, and, by the time the Domesday Book came to be written for the Norman Conqueror, the future great metropolis, the name of which is of Saxon derivation, was so unimportant as to be assessed at a mere four hides. Throughout the Middle Ages, Birmingham lay at the fringe and the intersection of the civil authority of three cities—Warwick, Worcester and Stafford. As a result of being approximately situated at the point where the three county boundaries met and by not suffering from lords of the manor or gilds and their restrictive practices, as did the more important towns and districts, Birmingham attracted craftsmen and merchants who pursued their activities in an atmosphere of almost complete freedom—"By the end of the Tudor period, therefore, we have a picture of Birmingham as a busy market and manufacturing town, already an important focus for much of the Plateau and places beyond, and enjoying a measure of political, social and economic freedom that was exceptional, if not unique in this part of the country". No doubt the modern 'Brummie' still possesses some of the character of his forefathers.

The natural assets of ironstone and wood for charcoal-burning led to the establishment of the individual iron-working craftsmen; but the district was also endowed with seams of Thick Coal that were easily mined on or near the ground-surface, though whether, on seeing the derelict land of the Black Country, this can be described as an asset, is a question for discussion. However, by the end of the seventeenth century, when coal had displaced charcoal, the population of Birmingham increased rapidly so that in a hundred years it achieved its position as the leading industrial city in England. From 1700 onwards the history of Birmingham is synonymous with the history of the steam engine and the successive developments in the ferrous industry. But the city also early developed a reputation for the manufacture of jewellery, toys, buttons and other trinkets, and this tradition is maintained to-day in the wealth of light industries that abound in the district. For, the uneconomical squandering and consequent exhaustion of the coal resources of the Black Country have left that nineteenth-century eyesore in a state where the smoke of the blast furnaces no longer belches forth; and, though coalfields have been developed in other districts round about, Birmingham can scarcely be said to be a centre of the heavy industries of Great Britain.

However, the unique engineering skill which evolved and accumulated in Birmingham and its satellite towns during the past few centuries has been passed down to the present generation, and the city in which Boulton and Watt first went into partnership and in which the short-lived Lunar Society shone so brilliantly is still maintaining the tradition by its multitudinous manufacturing industries, its technology and its University.

VITAMINS

Vitamin Methods

Edited by Dr. Paul György. Vol. 1. Pp. x+571. (New York: Academic Press, Inc., 1950.) 10 dollars.

Vitaminology

The Chemistry and Function of the Vitamins. By Dr. Walter H. Eddy. Pp. v+365. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1949.) 46*s.* 6*d.* net.

THE first of these two books, "Vitamin Methods", is a valuable work. Within its 571 pages will be found, gathered together for the first time, an exhaustive account of most of the better approved methods for estimating the twenty or thirty vitamins now known (and of their different forms, modifications, precursors, etc.). In each instance, full and explicit working directions have been provided, in order, as the editor says, "to spare the reader, as far as possible, the necessity of consulting other reference sources before a given assay method could be considered complete and workable".

Vol. 1 deals with physical, chemical and microbiological methods of determination, and Vol. 2, to follow later, will be devoted to biological assay. Nothing of this kind has hitherto been attempted, apart from the praiseworthy "Estimation of the Vitamins" ("Biological Symposia", 12; Lancaster, Pa., 1947), edited by the late W. J. Dann and by G. H. Satterfield, which is, however, a work on a definitely smaller scale; there is also the useful "Methods of Vitamin Assay" (New York, 1947), prepared and edited by the Association of Vitamin Chemists, Inc., which, however, confines itself to working directions for certain selected methods, and is in no sense a comprehensive treatise; and another valuable monograph, in French, is "Le Diagnostic Chimique des Avitaminoses, Techniques Actuelles" (Paris, 1942), by P. Meunier and Y. Raoul.

The plan of "Vitamin Methods" is unusual in one regard. Each author deals not with a particular vitamin, but with a particular technique, which he proceeds to discuss in its application to each of the vitamins in turn. Thus in the first 146 pages of the book, "Physical Methods of Vitamin Assay" are considered by E. T. Stiller, of the Wyeth Institute of Applied Biochemistry, Philadelphia, Pa. This portion, after a brief introductory section, describes one by one the methods involving ultra-violet absorption spectra, fluorimetric determinations and polarographic technique. There follows the section on "Chemical Methods of Assay", by P. György, of the School of Medicine, Philadelphia, Pa., and S. H.

Rubin, of Hoffmann-La Roche, Inc., New Jersey. This deals with colour reactions, fluorimetric tests, etc., in relation to twelve different vitamins or groups of vitamins (namely, A vitamins and carotene, D vitamins, E vitamins, K vitamins, vitamin B_1, nicotinamide, vitamin B_6, choline, inositol, *p*-aminobenzoic acid, folic acid, ascorbic acid).

The section on "Microbiological Methods", by O. A. Bessey, of the University of Illinois, begins with an adequate treatment of general principles, such as the collection of specimens, the measurement of small volumes, microcolorimetry and so on, and then describes the application of microchemical methods, not only to vitamins A and C, and riboflavin, but also to serum phosphatase, serum iron and serum protein. The account of microbiological methods is in the expert hands of E. E. Snell, of the University of Wisconsin. He divides his subject-matter into a description of the methods using (*a*) lactic acid bacteria, (*b*) yeast, (*c*) *Neurospora*, and (*d*) other micro-organisms. The book concludes with an excellent survey on the use of optical instruments in vitamin analysis from the pen of E. Hirschberg, of the Hoffmann-La Roche Nutrition Laboratories.

A difficulty facing the compilers of a book of methods in a subject developing so rapidly is to keep it sufficiently up to date. We can confidently expect that in later editions the editors will see to it that descriptions of some of the more obsolete techniques are abandoned in favour of more recent improvements. For example, for extracting carotene from plant tissues, grinding with acetone in the cold is to be preferred to digestion with alkali. Again, for the determination of vitamin A in blood, some allusion to Kimble's method is to be expected. For the measurement of vitamin E in tissues, reference to the newer developments in technique would no doubt be incorporated.

It will be observed that the authors comprise an all-American team. In this connexion, it is pleasing to record that the book is commendably free from national bias, and it nearly always gives credit where credit is due to fellow-investigators in other parts of the world. The authors, indeed, deserve to be complimented on the catholicity of their reading, on their historical perspective and on their balanced judgment. This is a welcome sign. Too often, in the United States, no less than in other countries, men of science have been tending to take the easier course of restricting their study of literature to the home market. The consequence sometimes has been that a method, originated by, shall we say, *R.* of Ruritania, and afterwards adopted, or adapted, by—let us call him—*U.* of Urbania, becomes known, before long, in the latter country as *U.*'s method. Such national exclusiveness in science is not a new phenomenon, nor limited to any country. A century and a half ago, Napoleon Bonaparte, who had made some study of the contemporary scientific scene, wrote, "I have been told that the English were accomplishing great things in Chemistry. . . . I assert, nevertheless, that the French possess ten times, and perhaps a hundred times, as much chemical knowledge as the English"[1]. Returning to the current scientific world, it is all the more refreshing to find a book so commendably free from this defect of national insularity.

There are a very full bibliography and author and subject indexes. The planning of the book and its format are both excellent.

Dr. W. H. Eddy's book, "Vitaminology: the Chemistry and Function of the Vitamins", will prove useful to a rather more limited audience, and in particular to the more highly specialized research worker. It is concerned especially with some of the biochemical aspects of recent vitamin research, and contains little detailed information about such matters as the pathology and the clinical effects of the vitamin deficiencies.

On the whole, the book can be regarded more as a useful compilation than as a critical study, and indeed the knowledgeable reader will find places where statements are quoted from the literature without comment, which have since been controverted or have failed to win acceptance.

A commendable feature is the large number of structural formulæ included. Unfortunately, however, many errors have crept in; and in a somewhat cursory preliminary inspection, I noted printers' errors, inaccuracies or inconsistencies in no fewer than thirteen of these formulæ (α-carotene, co-carboxylase, co-enzyme I, co-enzyme II, alloxazine, *iso*-alloxazine, indole-3-acetic acid, *p*-aminobenzoic acid, phytin, α-tocopherol, chroman, vitamin K, folic acid).

This work cannot claim to be a general text-book. Perhaps for this reason there is an entire absence of pictures, diagrams or illustrative curves. Much of the information which it contains is given in the form of a succession of summaries of—or, sometimes, quotations from—the original papers. This feature will make the volume useful as a source book to the advanced investigator, when he has occasion to conduct a search of the literature.

The references quoted are given in numerical order, section by section, and not according to the Harvard (so-called) system now generally used by biochemists; nor are the usual international conventions adopted in citing and abbreviating the names of the journals. There is no author index, and the subject index is not very full.

LESLIE J. HARRIS

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[1] Kircheisen, F. M., "Memoirs of Napoleon I", 243; translated by F. Collins. (London: Hutchinson and Co., 1928.)

BORDERLAND OF CHEMISTRY AND BIOLOGY

Chemical Constitution and Biological Activity

By Dr. W. A. Sexton. (Industrial Chemistry Series.) Pp. xxi+412. (London: E. and F. N. Spon, Ltd., 1949.) 55*s*. net.

THIS volume, to which Prof. A. R. Todd contributes a foreword, can best be described as consisting of a series of essays reviewing modern advances in our knowledge concerning the manner in which chemical substances can modify the functions of living organisms. While the book is directed primarily to chemical readers, the author expresses the hope "that it may have a wider appeal, and that those biologists who have an appreciation of structural organic chemistry may find in it material which will stimulate their interest and emphasize the enormous contributions which chemistry is now making towards the advancement of biological knowledge".

The first part of the book consists of an introduction, together with five chapters covering general topics, such as macromolecules, chemical mechanisms determining drug activity, physico-chemical considerations, the modification of drugs by living organisms, and the effect of specific chemical groups ; and the second part, consisting of sixteen chapters, covers a wide range of selected topics, such as growth factors and their antagonists (five chapters), porphyrins, choline and its derivatives, quinones, symbiosis and parasitism, antibiotics, some aspects of hormones, chemotherapeutic agents and insecticides (three chapters), cancer, plant growth regulators, and immunology. While many of these topics could, as some have already done, form the subjects of lengthy monographs, the author has attempted to embrace them all in a volume of less than four hundred text pages. The effect is that some of the chapters are admirable short surveys which do justice to the subject-matter, whereas others are too briefly kaleidoscopic. To compensate for the inevitable compression, Dr. Sexton has made good use of tables, nearly sixty in all, for the concise presentation of data ; and at the end of each chapter he has given excellent lists of leading references, these, in themselves a mine of information, being a most valuable feature of the work.

The two chapters dealing with pyridoxin, pantothenic acid, biotin, pyrimidines, purines, and pterins are excellent reviews, but it is indicative of the rate of progress that folic acid antagonists are scarcely mentioned. The chapter on plant growth regulators, to which Dr. Sexton's own researches have contributed notably, is a valuable review of a widely scattered literature, but the oat coleoptile test might have been described with greater accuracy.

Although written in a very readable manner, the work is marred by a considerable number of errors that should not have appeared in a book, which is not really a long one, costing as much as this one does. In the table of natural α-amino-acids, which is "given for reference purposes", the formulæ for thyroxine and threonine are given wrongly. These are not the only erroneous structural formulæ, which is to be regretted since a book of this kind giving a wealth of structural formulæ for many substances of topical interest is likely to be used for reference purposes in such matters. The following are given incorrect structural formulæ : eserine, tubocurarine, myanesin, endochin, benzoylglycuronic acid, phenylglycuronic acid, polyglutamic acid, and poly-N-acetylglucosamine, while the chemistry given for muscarine, formulated as the aldehyde corresponding to choline, was discredited many years ago. There is evidence also of lack of care in the rendering of scientific terms : thus, strepogenin appears repeatedly as streptogenin, and adrenochrome as adenochrome ; dibromosalicil appears as dibromosalicin, quite another matter, and the anthrax bacillus appears twice as *Bacillus anthris* and once, correctly, as *Bacillus anthracis* ; *P. cathemerium* appears as *P. cathemarium*, and a table of covalent radii is given under the heading of bond-lengths. Although the Chemical Society had misgivings about the term 'radicle' in 1905 and took another twenty years to replace it by 'radical', the obsolete rendering is consistently used in this book. The unfortunate impressions are given that riboflavin, rather than mepacrine, has antibacterial and antimalarial properties (p. 93), that aspirin will protect animals against the physiological effects of administered thyroglobulin or thyroxine (p. 387), and that the antiserum to a synthetic antigen derived from cellobiuronic acid, while precipitating the capsular polysaccharide of pneumococcus type III when the latter was combined with a heterologous protein, also "precipitated *antisera* to pneumococci types II, III and VIII" (p. 385).

The timeliness of a book of this nature will be readily conceded ; but it is to be regretted that a much-needed volume should contain numerous minor inaccuracies. Apart from the somewhat inelegant rendering of the porphyrin structural formulæ, the standard of printing is high, and the volume is attractively bound.

J. WALKER

VISUAL AIDS IN SCIENCE TEACHING

Visual Aids

Their Construction and Use. By Gilbert G. Weaver and Prof. Elroy W. Bollinger. Pp. vii+388. (New York: D. Van Nostrand Co., Inc. ; London: Macmillan and Co., Ltd., 1949.) 36*s*. net.

THIS book is superior in most respects to the large and well-bound volumes on visual aids to teaching, particularly to the teaching of technology, which appear at fairly frequent intervals in the United States. At the price of 36*s*. it must be regarded as expensive for a work of less than four hundred pages, many of which only deal with the problem from the American point of view.

The really useful part of the book discusses in a thorough though sometimes rather obvious manner the older direct and the newer optical projection methods of presenting material to students of the commoner technologies. Strangely, the authors seem to handle the methods which employ blackboards, display cases, posters and pictures with more conviction than they evince with the cinema and other optical devices. Perhaps this is all to the good, for the glamour of elaborate optical aids has tended to obscure their real purpose : they should be regarded as useful teaching tools and nothing more.

One of the main shortcomings in works of this kind is that they fail to stress sufficiently that the film, picture, model or diagram is in itself no cure for verbalism, even though each is thoroughly understood so far as its spatial, colour and temporal relationships are concerned. In the work under review, some space has been devoted to this important matter. The plain fact is that the scientific worker and technologist, in common with others, need languages to express their ideas and as vehicles of creative thought. It is necessary to spot the most convenient languages for the task in hand, whether these are verbal, symbolical or pictorial. This is true of both the research worker and the teacher. Further, there must be facility in translating from one language to another, and this is exactly where there is a failure to meet the needs of basic thought and teaching in science. The cure for verbalism is not the equally vicious complaint of pictorialism nor, in extreme cases, eidetism ; and in this connexion it is necessary to assess more critically the real educational value of many 'visual aids'.

It remains to be said that in spite of the very worthy production of the book, the half-tone illustrations with which it is illustrated have neither the size nor the quality desirable in a work of this type. Books on visual aids should set a good example.

W. L. SUMNER

British Inventions

By Dr. F. Sherwood Taylor. (British Life and Thought Series: Published for the British Council.) Pp. 44+16 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 1*s.* net.

It is a tribute to the author's judgment and ease of expression that so much has been compressed into such a readable compass. The result is far more than a mere catalogue of British inventions; Dr. F. Sherwood Taylor traces their origins in the needs and background of contemporary life. For example, Britain's obvious dependence on the sea is reflected in the multitude of marine inventions.

The sequence that the author has adopted contributes to an understanding of the development of invention and its relation to scientific discovery. After an introduction, with special reference to Francis Bacon, there follow sections on scientific instruments, textile machinery, machines to make machines, and the steam engine. The latter part of the book explains the rise of modern engineering and the distribution of power and has a special section on chemical manufactures.

This welcome additional volume to the British Council's series on "British Life and Thought" concludes with a survey of instruments in the nineteenth century and of British invention in modern times. Among the numerous excellent plates, there are three photographs—of the late Lord Rutherford, Sir Robert Watson-Watt and Air-Commodore Sir Frank Whittle—a happy reminder of the contributions that Great Britain has made to fundamental research of world-wide significance.

Differential Algebra

By Prof. Joseph Fels Ritt. (American Mathematical Society: Colloquium Publications, Vol. 33.) Pp. viii+184. (New York: American Mathematical Society, 1950.) 4.40 dollars.

In 1932 the author published "Differential Equations from the Algebraic Standpoint" (reprinted in 1948), which dealt with differential polynomials and algebraic differential manifolds. Since 1932 much progress has been made, so the author has prepared a new exposition, to which he has given the title of "Differential Algebra", which emphasizes that it deals with the three operations of addition, multiplication and differentiation. The problems dealt with are really closely allied to those of the usual theory of differential equations, but they are disguised by the abstract nature of the treatment. This treatment has been adopted so as to separate algebraic from analytical methods; but at times it seems rather unnatural, and the book is not easy reading.

Statistics

An Intermediate Text Book. By Dr. N. L. Johnson and H. Tetley. (Published for the Institute of Actuaries and the Faculty of Actuaries.) Vol. 1. Pp. xii+294. (Cambridge: At the University Press, 1949.) 20*s.* net.

The primary purpose of this book is to satisfy the needs of actuarial students studying for the examinations of the new syllabus of the Institute of Actuaries; the first section of this syllabus is covered in this volume, and the second section is to be dealt with in the companion volume. The first four chapters introduce the student to the subject-matter of statistics and to the methods of handling data by means of diagrams, moments and correlation techniques. A section on statistical inference introduces three chapters on probability, and the last two chapters are on large-sample statistical tests.

The text is well written, and, in particular, the notion of a statistical test is made very clear, though perhaps estimation is too briefly discussed. The exercises are, in general, too difficult, even when some hints and answers are given. The actuarial student will probably be well served by this book. It is difficult to say how well other classes will appreciate the book until we see the second volume. At the moment, the omission of small-sample theory and the preoccupation with some matters make the work less interesting than it might have been.

D. V. Lindley

Birds of the Coast

Written and Illustrated by C. A. Gibson-Hill. Pp. xxxii+216+16 plates. (London: H. F. and G. Witherby, Ltd., 1949.) 10*s.* 6*d.* net.

This volume follows the large handsome pictorial introductory volume, "British Sea Birds", by the same author and publisher; but it is pocket size and contains more reading matter. Even so, it is difficult to compress into two hundred small pages such a considerable and potentially intractable subject, since in Great Britain, a land of coasts and islands, almost every bird could pass the author's somewhat ambiguous test of what constitutes a coastal species. The author would have made a more useful contribution had he disciplined himself to describing the essentially littoral species, and giving more information about these, instead of introducing rare and inland-breeding species (for example, cream-coloured courser, pratincole, stone-curlew) and many others which only visit the shore occasionally in winter. There are several omissions from the distributional maps. The photographs are excellent, and the author's clear diagrammatic sketches of plumage markings are most useful. This work can be recommended as a pocket-size introduction to the birds seen on a seaside holiday.

Bees, Flowers and Fruit

The Story of Insect–Plant Relations. Written and Illustrated by Herbert Mace. Pp. 184. (Harlow: Beekeeping Annual Office, 1949.) 8*s.* 6*d.* net.

The author of this book, who is a well-known beekeeper and writer on apicultural subjects, has had a life-long interest in bee plants. His present work is written on popular lines, and the greater part is devoted to flowers and pollination with special reference to the role of the hive bee. Mr. H. Mace has drawn freely from Knuth's monumental and comprehensive work, "A Handbook of Flower Pollination", as he readily admits. As Knuth's work, in three large volumes, is not likely to be available to most beekeepers or amateur naturalists, Mr. Mace's book should fulfil a useful purpose in rendering at least some of the information more generally available. The chapters on bee pasturage, embodying many of the author's own observations, are among the more useful features of the book.

Some may feel that the title is somewhat misleading, for there is but little information on bees themselves and very little on fruit. Under the latter category notes are given on the nature of the flowers of tree, bush or berry fruits, their degree of attractiveness to the hive bee and their times of flowering. It seems unnecessary to have attempted to include cultural notes in a work of this kind.

MAN'S USE OF ENERGY*

By Sir HAROLD HARTLEY, K.C.V.O., C.B.E., M.C., F.R.S.
President of the British Association

FOR the sixth time the British Association is enjoying the hospitality of Birmingham, this great centre of industry and learning. It is a happy coincidence and a special pleasure to all that the Association is meeting in Birmingham in the jubilee year of its University. May I offer to the Vice-Chancellor on behalf of the Association our warmest congratulations and good wishes. Although the University of Birmingham is young, as universities go, it inherits the traditions of learning and culture that have flourished in Birmingham ever since the days of that brilliant galaxy of talent—Darwin, Galton, Boulton, Watt, Priestley and their friends—the Lunar Society. If we needed any reminder of the great part that Birmingham played in the Industrial Revolution, we have it in that admirable "Scientific Survey" for which all are most grateful to the authors. It was in Birmingham that the genius of James Watt found at long last the means and opportunity to complete his engine, that decisive step in the history of industrial progress.

What better setting could there be for the subject of my presidential address: "Man's Use of Energy". It seemed to me the natural sequel to Sir John Russell's address to the Association last year, and a fitting remembrance of the centenary of that landmark in the history of science, the Second Law of Thermodynamics, the law that governs the conversion of thermal energy to work of use to man.

It is only a century since man first understood the full import of the word energy and its significance as the driving force of all physical and chemical change and of life itself—what Clerk Maxwell called "the go of things"; and yet it has been man's use of energy that shaped so largely the material progress of the human race. Among the milestones of that early progress are the discovery of fire, the raising of crops, the invention of tools, weapons, the wheel and machines, the copper, bronze and iron ages, and the use of animals, wind and water as sources of power.

Throughout the ages the dependence of the human body on food and warmth, and the demands of man for energy, have helped so much to shape the course of history. Even in this machine age of civilization, with the huge demands of industry and transport for heat and power, in Great Britain at least one-third of the energy consumed goes to satisfy our personal needs of heat and warmth and food; and so, man's own needs, the energy by which life is sustained, will be the starting point of this address.

Energy and the Human Body

Why does the body need this energy? Just as a ball of celluloid poised on a jet of water from a fountain will keep its place and spin so long as energy is there, so life depends upon that flow of energy. Even in sleep the muscles of the heart and lungs must maintain the circulation of aerated blood to meet the body's need of energy through the chemical reactions on which the steady state of living matter rests. We know from radioactive atoms, by which the movements of matter can be traced, that all parts of the body, even the bones, are being constantly renewed.

Then there are the muscles, on the movements of which life in turn depends. The intimate mechanism by which they derive their energy, their power to work, by chemical reactions from the intake of food and oxygen, is still one of Nature's secrets. It is a mechanism much more subtle than the internal combustion engine, as it works at constant temperature. The outstanding fact about the human body is that all its manifold changes and adjustments, thanks to Nature's catalysts, take place at the steady temperature at which evolution has decided that the body should work.

Comfort and life itself depend on that constant body temperature. Clothing, domestic heating and air conditioning are all designed to meet the body's thermal needs in its environment. The body mechanism can respond to a demand for greater heat production or its dissipation, but the demands on it are least in temperate climates with no extremes of heat or cold. Markham, following this clue in his book "Climate and the Energy of Nations", points out that the earliest civilizations were in the warm fertile regions of the Middle East and Southern Mediterranean. As the art of living improved with housing and domestic heating, dominance passed to the temperate climates, where it has since remained. Birmingham, I am glad to say, falls within Markham's zone of optimum conditions for man's creativeness.

But let us return for a moment to the destination of the energy consumed by the body when asleep. If fatigue is of the nature of some disturbance of the steady state, some of the energy may go to readjustment, to Nature's running repairs. It is significant that no less than a quarter of the intake goes to the brain, even when the organs of external sensation are at rest. It seems an enormous consumption for its weight, but it is maintaining the active state of the ten thousand million nerve cells of which the brain is composed. We speak of grey matter or the lack of it, and the grey matter consumes two to four times the energy needed by the white.

Why does the brain need this great expenditure of energy? Probably because it is the integrating unit, the control room, on which depends the marvellous efficiency of the body, the accurate co-ordination of sense and action; and the memory, that vast storehouse of impressions, must be kept alive like the automatic memories of the electronic calculators, but with an immeasurably greater efficiency. Even in sleep the subconscious mind is working with the flow of energy, and who can say how much we owe to it? In our researches we can plan our measurements and observations, accumulate new facts, but the flash of inspiration that marks the great advances comes from the "deep wells of unconscious cerebration"; it is not at our command.

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* From the Presidential Address delivered at Birmingham on August 30.

Life is dynamic, and the slender thread on which it hangs is that ceaseless flow of energy.

I must not dwell longer on these fascinating unsolved problems of the power engineering of the body and the human brain, or the mechanisms by which energy performs its tasks. Gilbert Lewis once asked if living things "were cheats in the game of entropy?" Does Nature even here obey her laws of energy? This we may never know for certain, but the presumption is—she does.

Man's Progress in the Art of Living

Man's progress in the art of living, the environment he has created for himself with its ever-increasing call for energy, is the product of the human brain. Its curiosity, its creative ingenuity, its ability to observe and take advantage of the unexpected, reflect its gradual evolution through man's efforts to improve his lot.

For a million years man was "the servant of untamed Nature", and only when he learned to tame her to his needs, to kindle fires and grow his food, did the social evolution, that made us what we are, begin. "Man", said Carlyle, "is a Tool-using animal. Weak in himself and of small stature, he stands on a basis, at most of the flattest-soled, of some half square foot, insecurely enough. . . . Three quintals are a crushing load for him: the steer of the field tosses him aloft like a waste rag. Nevertheless he can use Tools, can devise Tools . . . without Tools he is nothing, with Tools he is all!"

The story of material progress is man's invention of tools to make his muscular work more effective, or to store it and raise its potential as with the bow and arrow, his invention of machines to multiply his force and ease his tasks, or to repeat them with accuracy independent of the hand or eye. Animals, wind or falling water gave him the energy he needed to multiply his effort. The successive metal ages—copper, bronze and iron—mark man's discoveries of new materials from which to make his weapons and machines, and his inventive use of energy in fuels and furnaces to smelt their ores.

The Industrial Revolution

Even in those far-off days the name of engineer reminds us of the impetus that came in use of energy when man's mind was focused on the military art. Nevertheless progress was slow, with little help but trial and error save for a brief period among the Greeks, until the new freedom of the mind that came with the Renaissance and its spirit of inquiry taught man to question Nature by experiment and to read her answer. That was the birth of modern science. In his "New Atlantis", Francis Bacon made a prophetic forecast of the spirit and the optimism of the Scientific Age—"The end of our foundation", he said, "is the knowledge of causes and of the secret of things, and the enlarging of the bounds of human empire to the effecting of all things possible". At the same moment the experimental study of mechanics by Galileo was yielding a fresh understanding of machines and quickening the tempo of invention. In Great Britain, with the impetus that social freedom gave to industry, with the momentum of the Elizabethan age, and with our native genius, the times were ripe for change. It was in Britain that the machine age, the Industrial Revolution, with its dependence on energy, began. It was a great century of British invention. In textiles, Kay's flying shuttle, Hargreaves's jenny, Arkwright's frame and Crompton's mule led the world. Darby's discovery of smelting iron with coke instead of charcoal and Cort's reverberatory furnace and rolling mill for making wrought iron brought the blast furnaces and forges northwards to the coalfields from the woodlands of the South. Not all the improvements in machinery came from the users and makers of machines, but "some", as that shrewd old observer Adam Smith records, "by the ingenuity of those who are called philosophers or men of speculation, whose trade it is not to do anything, but to observe everything; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects". So science played its part.

It was a time of rapid growth, and with the advent of the factory and machines, supplies of power from water-wheels and animals were soon the limiting factor. For fifty years Newcomen's atmospheric engine had been the only means of draining mines as they went deeper to meet the growing needs of coal and iron, and no improvements had been made in its efficiency of one half of one per cent.

Watt's Steam Engine

Then in 1764, by one of those chances that make history, a model of Newcomen's engine went to a young Glasgow instrument-maker to be repaired. It stirred in the mind of James Watt a restless urge of his inventive genius and his intuition for mechanical design. Watt was not satisfied; he saw the waste of steam and instinctively he attacked the problem by the scientific method, by measurement. He measured the boiling point of water at different pressures, and the volume of steam formed from a volume of water; he made a model to show the quantity of steam used at every stroke of the cylinder. He was puzzled to find that steam could heat six times its weight of water from room temperature to boiling point, which Black explained to him by his discovery of latent heat. It was not until the following May that, in a flash of imagination on a walk, Watt saw that the waste of heat could be avoided by condensing the steam in a separate vessel, the condenser of the modern power unit. As he said, "I had not walked farther than the Golf House when the whole thing was arranged in my mind!" A hastily made model, of which a thimble, presumably his wife's, was part, satisfied him that he was right; but it was ten years before, in Birmingham, the first engine was made to his design, marking the birth of a new age of civilization.

Watt had now to earn his living as a surveyor, and, despite the help of friends and his partner Roebuck, the engine made slow progress. In 1768 he rode to London, took out a patent, and on his way north he went to Birmingham. There Matthew Boulton, with the ambition, the enthusiasm and the vision of a great industrial venturer, had just built the Soho works, the prototype of a modern factory. Watt saw there the opportunity to build his engine, while Boulton's quick eye saw the engine meeting the needs of industry for power. Watt's partner offered Boulton a licence to build engines for the Midlands; but Boulton's mind was moving on a grander scale, and his answer reveals the wide sweep of his imagination. "It would not be worth my while", he said, "to make for three counties only, but I find it very well worth my while to make for all the world". So for six years Boulton waited until Roebuck's bankruptcy gave him the opportunity he sought, and then Watt came to Birmingham as his partner with his engine still unfinished. Within a year the first two engines were erected, the first at Bloomfield Colliery in Staffordshire, and the next at John Wilkinson's new foundry at Broseley to raise the water to drive the blast. Their success owed much to Boulton's encouragement and help and to the accurate cylinders made by Wilkinson's new machine tool with a limit of error not exceeding "the thickness of a thin sixpence" in a diameter of 72 inches.

The immediate market for the Watt engine was to drive the pumps in the Cornish mines with an efficiency four times that of the Newcomen engine. Watt went himself to erect them until another Scottish inventor, William Murdock, walked from Glasgow to Birmingham following Watt's footsteps. Watt was in Cornwall, and the interview with Boulton was not going well when Murdock's hat fell on the floor. Boulton noticed the noise. "What's it made of ?" he asked. "Timmer, Sir," said Murdock, "I turned it myself on a bit lathey of my own making". Boulton recognized the skill and knowledge that had gone into the making of a lathe that could turn an oval, and it was not long before Murdock was building Watt's engines in Cornwall and settling arguments with the miners with his fists. It was there that he invented the first gas lighting for his home in Redruth and built the first model of a steam-driven carriage, that the vicar on a dark night mistook for the devil himself. While Murdock was erecting the engines, Watt was back in Birmingham busy with successive improvements to add to those he had already made —the tubular condenser, the steam-jacketed cylinder, the double-acting piston, expansive working, parallel motion, the governor, and the indicator to measure the work done in terms of horse power, Watt's unit that we still use to-day.

'Invention is the mother of necessity', and Boulton realized that the machines that were being invented in quick succession needed rotative power to drive them. "The people in London, Manchester and Birmingham are steam mad", he wrote to Watt, urging on him the need to take out a patent for "methods of producing rotative motion from the fire engine". Watt's cautious nature was intent on the success of his Cornish engines, and Boulton persuaded Murdock not to go to London to patent his steam carriage lest it should divert his energies. The first rotative engine was built in 1782 with Murdock's sun-and-planet gear. It was an immediate success, and by 1800 some five hundred engines in all had been built by Watt and Boulton, with a total output of 7,500 h.p., making together a twentieth of the output of a 100-megawatt generator of to-day.

Murdock's invention of gas lighting, like his steam carriage, was never patented. Soho was the first factory to be lit by gas, and it was illuminated by gas to celebrate the Treaty of Amiens in 1802. The gas-making plants made in Soho were being installed in textile works when Albert Winsor came to London with a scheme for distributing gas to private houses and for street lighting, the first plan for the distribution of energy. The absence of a patent weakened Murdock's opposition to the monopoly Winsor sought, and in 1812 the Gas Light and Coke Co. got its charter ; but the gas engineer who made it a success was Samuel Clegg, who had been trained by Murdock at Soho. So Birmingham is the first home of the gas industry as well as of the steam engine.

1800–1850

Watt's patent ended in 1800, and the field was open to Trevithick's high-pressure engine with its greater efficiency. Progress at first was slow ; even in Birmingham by 1820 there were only sixty engines with a "total steam-power in horses" of 1,000. But in the coal mines and the blast furnaces, steam power was indispensable to the production which was soon to make Britain the "workshop of the world". Sadi Carnot saw this so clearly in his classic essay on "The Motive Power of Heat". "To rob Britain of her steam engines", he wrote in 1824, "would be to rob her of her coal and iron, to deprive her of the sources of her wealth, to ruin her prosperity, to annihilate that colossal power".

In the cotton mills and steamships also, steam power was forging ahead. Fulton's *Clermont* with her Soho engine was the prototype in 1807 of the steamboats which were to open up America long before the railroad. But it was the triumph of Stephenson's *Rocket* in 1829 that heralded the new era, the harnessing of energy to production and transport on a scale that made possible the great expansion of the nineteenth century. In the factories steam-driven machines increased continuously the productivity of labour, and the rapid growth of the metal and chemical industries was dependent on supplies of heat and power. The steamship routes and the railways—the new arteries of commerce—quickened the flow of goods and men, and made accessible the raw materials of virgin lands and their new markets for industry. In the economic histories of these times, there are statistics of every kind, except the growth of horse power, without which that great expansion of human effort could not have been ; but coal, the source of heat and power, is an index of development. In 1700 the output of coal in Britain was 3 million tons, or half a ton per head of population, and in 1800 it was twice as much per head ; but by 1850, 60 million tons were being used, or three tons per head. In these years of rapid growth, practice, as so often happens, outran theory. There was no theory of the conversion of heat to work. It was an empiric age, when even Thomas Tredgold described the calculus as a device "for forcing the assent rather than by convincing the judgment". Until 1850, as L. J. Henderson used to put it, "The steam engine did more for science, than science did for the steam engine". But then, a century ago, came swiftly the idea of energy and the recognition of its laws, that great divide in engineering between the old and new.

The Laws of Energy

Carnot, a young French engineer, realizing the importance of a clearer understanding of the working of the steam engine and its complexity, simplified the problem by his conception of an ideal engine working in a reversible cycle. His stroke of genius in recognizing that the efficiency of his ideal engine must be independent of the working substance was the first step towards a general theory of energetics. He was the first to show that the efficiency of a heat engine depends on the temperature drop between the cylinder and the condenser. His forecast of the internal combustion engine reveals his clear grasp of the engineering principles that are involved. If he had not died in 1832, his notebooks show that he would have anticipated much that came after him. As it was, his ideas had to wait a quarter of a century for recognition.

Next came Mayer, a young German medical man, who noticed when he bled his crew for fever on their arrival in the East Indies that their blood was redder than it would have been at home. He decided rightly that this was due to the reduced demand for heat to maintain the body temperature in the tropics. This set him thinking on the whole problem of the causal relationship of what he called the imponderables—work, heat and electricity—and led him to the theory of the interconversion but indestructibility of these various forms of energy. Once, when he was asked how he became involved in this problem, he replied, "Engaged during a sea voyage almost exclusively with the study of physiology, I discovered the new theory for the sufficient reason that I vividly felt the need for it". He calculated in 1842 the amount of work equivalent to a unit of heat and pointed out the inefficiency of the best steam engines of his day.

In 1847 Helmholtz, then a young army surgeon, from his study of metabolism, animal heat and muscular work was led along the same path as Mayer to consider what the relations must be between the different forces of Nature—heat, electricity, magnetism and chemical affinity—if perpetual motion is impossible. From a masterly analysis he reached the conclusion that "Nature as a whole possesses a store of energy which cannot in any wise be added to or subtracted from : the quantity of energy in inorganic nature is as eternal and unalterable as the quantity of matter". The effect of this new principle of the Conservation of Energy, the First Law of Thermodynamics, was to divert physical research into an entirely new channel. "Its object", said Hertz, "was henceforward to refer all phenomena in the last resort to the laws which govern the transformation of energy".

Meanwhile, Joule was attacking the same problem in Manchester by measuring the relation of work to heat in a series of researches which for insight, ingenuity and accuracy, with the means at his disposal, are unsurpassed. Joule was a faithful member of the British Association, which gave him scant encouragement. At seven successive meetings he read papers without any record of discussions. In 1843 his paper on "The Mechanical Value of Heat" was read to a chilly audience of six. At Cambridge, two years later, his paper on the measurement of the heat developed by rotating paddle-wheels in water excited no interest; but at last at Oxford in 1847 William Thomson, fresh from helping Regnault with the first 'steam tables', and from reading Carnot's essay, saw the importance of Joule's paper on "The Mechanical Equivalent of Heat", though he was sceptical of Joule's interpretation. Their meeting led to one of those fruitful friendships and partnerships which the British Association has done so much to foster. Looking back, too, at the conservatism of a century ago and at the personal bitterness and opposition to new ideas that sometimes it engendered, I like to think that in this respect, at any rate, we can claim progress in the more sympathetic and interested hearing that new ideas receive both in the Association and in the world outside.

Even in 1849 Thomson had not shaken off the eighteenth-century idea of heat as something invariable in quantity like matter, thus showing how novel was the new idea of energy. So it was left to Clausius, a young German physicist, in 1850 to reconcile Carnot's theory of the heat engine with the newly discovered equivalence of heat and work and to formulate the Second Law of Thermodynamics in the general statement "that heat cannot of itself pass from a colder to a hotter body".

Rankine, a brilliant Scottish engineer, reached the same conclusion from his theory that heat is due to the rotation of molecular vortices. He had the conception of the thermodynamic function which Clausius later called 'entropy'. Rankine's analysis of the energy changes during the expansive working of the steam engine was later known as the Rankine Cycle and became the basis of design of steam prime movers.

Then Thomson recanted, and, having seen the light, with a bold sweep of imagination he surveyed all the sources of energy available to man for the production of mechanical work and recognized the universal tendency in Nature to the dissipation of energy. From it he drew the conclusion, momentous as it then seemed, that the earth must in time become too cold for human life. Our astronomers may give us a very different answer to-day.

So, starting from the theory of the steam engine, as the word thermodynamics reminds us, there came a gradual realization of the common driving force behind all physical and chemical changes, and of the laws of energy which govern them. Those laws, independent of hypotheses as to the nature of matter or of process, in the hands of Helmholtz, Willard Gibbs, van't Hoff, Planck and Gilbert Lewis, have become a universal instrument of great power and great economy in predicting what is possible. The height of a blast furnace was once doubled at great cost to see if the reducing power of its gases could be increased. Thermodynamics could have given the negative answer on a sheet of notepaper.

By 1850 industrialization and the use of power was spreading from Britain to other countries with great demands for energy. Between 1850 and 1900 the world's coal consumption increased from 100 to 1,000 million tons a year, and the route mileage of the world's railways grew from 25,000 to 600,000 miles. It was a time of rapid change, when the modern interplay of science and technology was taking shape and invention followed quickly on necessity. The steam engine made great progress in efficiency and size to meet the growing need of power. Double, treble and quadruple expansions followed one another to get the maximum amount of useful work from the higher-pressure boilers. Designers were slow at first to profit by the new theory, and improvements came mainly from details of mechanical design.

1850–1900

Two new ventures in the field of energy were destined soon to change the technical and social pattern of the world as steam had done a hundred years before. Since Murdock's day the gas and hot-air engines had been a favourable field for inventors. until with the work of Lenoir, Rocha and Otto the gas engine became a practical reality in the 'seventies, and the supply of town's gas made it a convenient source of small-scale power. Carnot's cycle gave it promise of greater efficiency than steam, and scientific enthusiasm was on its side. At the jubilee meeting of the British Association at York in 1881, Sir

Frederick Bramwell, speaking of the transmission of power by gas, predicted that in fifty years the steam engine might be spoken of as a curiosity to be found in a museum! Prophecies to the Association that are a challenge to the technician are apt to be belied, and it was only three years before Parsons's turbine rescued steam from its predicted fate. However, Bramwell's optimism about the gas engine was justified, though not as he foresaw. In larger units its promise of success was not fulfilled, but its progeny, the petrol engine and the diesel, are to-day in aggregate the greatest power producers in the world. The sinking of the first oil well in Pittsburg in 1859 saw the birth of a great industry, a new source of energy, which in the hands of Diesel and Daimler and many other eager spirits has given us the internal combustion engine of to-day with its far-reaching uses.

Even such an optimist about the gas engine as Fleeming Jenkin soon saw a cloud on the horizon. In 1882 he wrote to Ewing, "The gas engine goes slowly, its nose is put out of joint by this electrical affair". For the beginning of that "electrical affair" we must go back to 1831. Faraday, with his instinctive belief in the essential unity of the forces of Nature, was convinced that electricity could be obtained from magnetism as magnetism had been obtained from electricity. Time and again he experimented without result, until on August 29, 1831, the induced current was detected. Ten days of decisive experiment culminated in his paper on "The Induction of Electric Currents" which was to shape the future of electrical science and electrical industry. The discovery of electromagnetic induction gave a new impulse to Faraday's mind and gave him confidence in the flights of his imagination which inspired his "Experimental Researches in Electricity". These in turn, translated by Clerk Maxwell into mathematical form, led him to the electromagnetic theory of light and to the conception of electromagnetic waves, which in the hands of Hertz became the basis of wireless.

Faraday's discovery set the inventors' minds working, and one of the first uses of electromagnetic machines was in electroplating. In 1845 Faraday visited Messrs. Prince's works in Birmingham to see the Woolrich generator at work. "I shall never forget", wrote John Percy, "the sparkling delight which he manifested on seeing the result of his purely scientific labours, rendered subservient to a beautiful art and to the advantage of others".

In 1861, foreseeing the need for universal use of a system of electrical units based on certain fixed standards, the British Association appointed a strong committee to investigate the subject. The system of units based on the centimetre, the gram and the second adopted by this committee and the standard ohm constructed by them were afterwards adopted internationally with minor changes. In this way the Association rendered an outstanding service to the progress of electrical science and engineering.

By 1870, with the dynamos of Pacinotti, Siemens and Gramme, the generation of electric current was reaching an economic stage, and its use for lighting by the arc was growing. But it was the invention of the carbon-filament lamp by Edison and Swan that in 1880 gave the first great impetus to the electrical industry. The next landmark was Edison's power station in New York with its D.C. generators providing low-voltage lighting current for the neighbourhood. This was the pattern of development until Ferranti saw that the future of electricity supply lay with the high-voltage transmission of alternating current generated at some convenient point outside a city. No difficulties daunted his inventive brain, and the construction of the Deptford power station with long high-voltage line to London was due to his creative skill. Alternators, cables and transformers were all made to his design, and they ran for thirty years, the prototype of the modern power system.

Meanwhile, Parsons's discerning eye had seen that the marriage of the reciprocating motion of the steam engine to the rotation of the generator was an unnatural union. The turbine had been a dream for at least two thousand years, but, with Parsons's genius for design, in 1884 his first experimental model came like Minerva fully armed. A century before, Watt summed up his sagacious answer to Boulton on the competition they might have from Kempelen's steam turbine with the words: "In short, unless God makes it possible for things to move a thousand feet a second it cannot do much harm". Mechanical progress and Parsons's genius had made the impossible possible, and with it came that smooth continuous high-speed drive that is the key to so much of modern engineering. Forty crowded years of investigation and experience have scarcely changed the profile of the blading that Parsons's intuition shaped in 1896. As Kirchhoff said of Faraday, "He smells the truth". With the turbine and the high-pressure boiler, the polyphase alternator with its rotating magnetic field, and the electric motor, steam and electricity entered on a new age of power.

Energy in the Twentieth Century

The last half of the nineteenth century was a period of continuous expansion. The steady rise in world production, following the law of organic growth, seemed to justify the satisfaction of the Victorians and their optimism about the future. In science, too, the edifice of classical physics seemed almost complete. But the twentieth century was destined to be a time of rapid and revolutionary changes both in science and technology, in which man's use of energy was to play a decisive part. With the turn of the century a series of discoveries gave a new insight into the nature of matter and of energy and their relationship: radioactivity by Becquerel, X-rays by Röntgen, the electron by J. J. Thomson, the nucleus by Rutherford, the quantum theory of energy by Planck, and relativity by Einstein. Those discoveries changed profoundly man's understanding of Nature's processes and gave him new techniques and new tools, which quickened the pace of scientific advance in every field. Meanwhile, the rapid progress of electricity, of the internal combustion engine and of wireless were creating equally profound changes in the social and technical pattern of the world.

The central power station, hydro-electric plants, and the high-voltage transmission of electricity made power available over wide areas both in the factory and in the home. The distribution of power encouraged the dispersal of industry, it substituted for the steam engine the more flexible electric drive, and it gave a great stimulus to mechanized production. The hundred-fold increase in the world's consumption of electricity between 1900 and 1950 was accompanied by a six-fold increase in efficiency of generation.

The gas industry, foreseeing the inevitable loss of the lighting load to its younger rival, concentrated its efforts on the economical supply of heat and on its by-products. By scientific methods its efficiency has been raised to nearly 80 per cent. In countries that are fortunate enough to possess reserves of natural gas—the ideal fuel—high-pressure mains have been built to carry it great distances. To-day gas provides in all 9–10 per cent of the energy requirements of the world.

In 1900 the production of oil was 20 million tons, by 1925 it had increased to 150 million tons and by 1950 to 500 million tons. Vacuum distillation of oil came in with the new century; by 1930 methods of refining had so progressed that oil could be tailored to meet the needs of the market with an ever-expanding demand for high-octane petrol. Since then, catalytic cracking and the so-called fluid catalyst have set a new high-water mark of efficiency in oil refining.

In 1900 there were less than 20,000 motor vehicles in the world; in 1950 there are 62 million. The coming of the motor vehicle has made a radical change in social conditions from the new mobility it has given to life in every country.

It was, too, the progress of the petrol engine, with its six-fold increase in power output from cylinders of equal size, and the reduction of its bare weight per horse power from 4·5 lb. in 1905 to 1·1 lb. in 1950, which made possible man's conquest of the air and changed the whole relationship of nations by the speed of personal contact it provided; and now, with the coming of the jet, men may fly even faster than the waves of sound. But speedier still is wireless, which carries the human voice across the world in a fraction of a second, while television brings to light the distant scene.

Then in agriculture, the replacement of the horse by the tractor and the use of power on the farm have given a new impetus to development. They have increased the output per unit of labour and thus made good the drift of man-power from the land. In England and Wales the total farm supplies of power (excluding transport) rose from more than one million horse power in 1908 to two million in 1939 and five and a half million in 1948. Of this, horses provided 87 per cent in 1908, 25 per cent in 1939, and only 7 per cent in 1948. In the United States mechanization of the large wheat farms has reduced the labour requirements per acre by three-quarters.

In addition, the availability of energy has made possible a new partnership between agriculture and industry in the processing of farm products. Canning, refrigeration and deep freezing, conditioned transport, crop drying, fermentation processes, and the conversion of farm residues into useful products have all opened new outlets for the farmer.

Side by side with this new pattern of energy in industry and agriculture has come another change no less far reaching—the Domestic Revolution—the scientific application of heat and power in the home, which has done so much in this century to help the housewife and to raise the standard of health and comfort. It may be regarded as the repayment by the technician of a debt long overdue for some of the social evils of the Industrial Revolution.

What measure have we of the significance of energy to man to-day? In the nineteen-thirties the correlation between the average real income and the consumption of energy per head in different countries was so close, with a few exceptions, that it showed how essential supplies of energy are if a reasonable standard of life is to be maintained. Energy is the multiplier of human effort. But its effects are not found in comfort and productivity alone. The rapid interchange of persons and ideas has brought the world together into a much more closely integrated unit. It has quickened the senses and the nerve fibres of nations and given them a new awareness of events, a new world consciousness which in due time must show their inescapable community of interests.

With all these new uses of energy and its growing population, the world's demands are rising daily. How can they be met? Sir John Russell's problem last year of the world's demand for food was simple compared with mine. There is a limit to the capacity of the human stomach, but none to man's appetite for energy; and he finds new uses for it every day.

World Consumption and World Resources of Energy

The world's consumption of every kind of energy to-day, food for men and beasts, heat, light and power, needs a gross yearly intake equivalent to four thousand million tons of coal. On a thermal basis this demand is met by food from agriculture 21 per cent, by coal and lignite 41 per cent, by wood 6 per cent, by oil 24·5 per cent, by natural gas 6·5 per cent and by hydro-electricity 1 per cent; so that about 30 per cent comes from the current revenue of plant and animal growth and water power and the remainder from the capital resources of coal and oil. Leaving aside the work equivalent of human and animal labour, and taking into account the efficiency with which the other energy sources are applied by man, their useful contributions to-day are, roughly, solid fuel 56 per cent, liquid and gaseous fuel 37 per cent and water power 7 per cent.

What of the future? How long can the world's resources meet these growing demands? The world's reserves of coal are ample for centuries. Reserves of oil and natural gas are smaller, and harder to define; but fresh fields are being found, and there is no reason to fear a shortage for some decades. Before then, synthetic oil from coal and the huge reserves of oil in shale will provide substitutes. Turning now from fossil fuels to current revenue, if the world's reserves of water power were all to be developed, their output would equal the total inanimate energy man is using to-day. But these reserves are scattered, and many lie in distant regions far from the crowded areas of the world—in the Belgian Congo, French Equatorial Africa, the Cameroons and South America; and like coal and oil there is a most unequal distribution of resources between nations. The countries north of latitude 20° contain 94 per cent of the world's coal reserves and 83 per cent of the oil reserves, while those to the south contain two-thirds of the world's water-power potential, so that the pattern of development of countries, which must be related to their energy resources, will inevitably be very different.

But our energy problems of the future are not limited to heat and power alone. Reserves of fertilizers for the growth of food and of metals for the machine age in which we live are of equal moment. Fortunately for agriculture the deposits of phosphates and potash will meet our needs for centuries, and nitrogen can be fixed from the air. But again, the reserves of phosphates and potash are most unequally divided, marking the dependence of one country on another.

Reserves of metals may present the world before long with a much more difficult problem. There will be no lack of iron, aluminium or magnesium, although with lower grades of ore the cost may rise. Estimated reserves of copper, zinc, lead and tin are adequate only for some decades, and, if all the world used them at the same rate as the United States, there might be shortages within ten years. Geologists are not optimistic of finding large new ore fields, and so we shall be faced with an iron/light alloy metal economy, reserving certain non-ferrous metals for the uses for which they are essential. Here again, the accidental distribution of ore deposits reveals the interdependence of countries in an acute form.

The global sufficiency of energy reserves is but a poor consolation for the countries that have few. The recent State Department Survey shows that half the world's visible reserves lie in the United States or the U.S.S.R., and another third in nine other countries. Of the remainder, none can claim as much as one per cent, so that their long-term development may call for new techniques. These inequalities are reflected in consumption to-day. At one end of the scale the United States use yearly the equivalent of 9 tons of coal per head, while at the other India and China are using less than one-fifth of a ton per head. The figure for Great Britain is a little more than 4 tons, of which one-third provides domestic needs of heat, warmth and food, leaving nearly 3 tons for transport and industry.

What part is energy to play in the problems the world is facing now—the destruction and disruption of war, the economic unbalance of the older countries, and the claims of the less-developed countries with their ill-nourished millions for a better share in the world's dividends ? Energy is essential to increased production both in the factory and on the farm. The needs of the more backward countries are transport, fertilizers, irrigation, heat and power : transport to diversify their social and economic pattern ; fertilizers to sustain and increase fertility ; irrigation to bring the water on which all life depends ; and heat and power to develop their indigenous resources.

The Need for Greater Efficiency

All this means fresh demands. The nineteenth century was wasteful of its easily won materials, but now, thanks to the continuous improvements in technique, the world's demands for heat and power are being met largely by improved efficiency. In Britain until 1938 the total fuel consumption was almost unchanged for a quarter of a century. During that time the population increased by ten per cent. The use of heat and power in industry was extended to secure increased production from human effort. New industries arose, and the standard of domestic comfort increased. The striking fact emerges that the additional energy required with the progress in those years came from the same amount of fuel by increased efficiency of use. But, as the war-time economies proved, there were still great improvements to be made, and that is still true to-day.

What are the prospects of meeting future demands by improved efficiency of existing practice, by the transport of energy or by new methods and new sources ? To simplify the problem I will discriminate between the four energy industries—coal, electricity, gas and oil—and the uses of the products they provide. It is in the energy industries that the major advances have been made. The most modern types of plant in each have reached a point where only fractional progress is likely to be made, and where the limits may be the discovery of new alloys or the higher cost which the gain in efficiency would not justify. There are still large savings to be made by raising the standard of all plant to that of the best practice. The generation of electricity has a special problem of its own—the loss in the cooling water of the condensers of about sixty per cent of the heat employed. Where steam is needed for any purpose in addition to power, this loss can be avoided by using steam from the low-pressure side of the turbine instead of condensing it. In industries using steam, the generation of electricity before the steam is used for heating purposes would secure large fuel economies. The other plan of using low-grade heat for district heating involves heavy capital costs if it is introduced in built-up areas, unless hot-water heating systems are already installed ; but it would be more attractive in new development schemes with a sufficient density of population. With the continuous increase in the demand for electric power and the heavy capital cost of generating equipment, the problem of the combined use of heat and power is of major importance.

Turning now from the energy industries to the use of heat and power in industry, in transport and in the home, it is there that inefficiencies of one kind or another combine to make the overall efficiency of use in Britain probably less than 15 per cent. Here is the urgent need for large economies to save the coal that will be needed for increased production. The future of British industrial efficiency will be closely linked with the efficient use of coal, the main raw material on which British prosperity depends.

To-day's Developments

Before looking to the future, let me touch on a few developments that lie immediately ahead. The gas turbine, a new prime-mover, has proved itself for aircraft use both as turbo-propeller and turbo-jet. Several land and marine types are now being developed to use gaseous, liquid or solid fuels. It has the advantage of compactness, it can be used where no cooling water is available, and it is specially suitable for burning by-product or waste gases. Underground gasification of coal is being tried in several countries, and, if successful, the gas turbine may possibly be the best means of utilizing the gas obtained. In Britain much depends on the success of the gas turbine using coal by one means or another.

Kelvin's heat pump, the refrigerator in reverse, with its high efficiency of power in supplying domestic heat is now on trial. Its economy is greatest in latitudes where its use for air-conditioning in summer balances its use for heating in the winter. In industry, too, the principle of the heat pump is being applied with great economy to recover the heat lost in evaporation.

In Italy the internal heat of the earth has been used successfully in a geothermal power station on an ever-increasing scale for more than thirty years. Difficulties and dangers in drawing steam from great depths and using it have all been overcome. Italian engineers and men of science have set a great example that could be followed wherever thermal springs or volcanic steam are found.

Few advances have been made in using wind power, one of the earliest forms of energy used by man; but now, with the progress in aerodynamics, new experiments are being tried which may produce power economically to be fed into a grid system and thus save coal. At favourable sites in Britain it is expected that wind-driven generators weighing about 300 lb. per kW. will produce 4,000 kWh. per kW. per annum.

Future Possibilities

What new means of tapping Nature's stores of energy are likely to emerge and bring it where it is needed ? The unequal distribution of energy sources will make its transport of increasing importance in the future, and here the possibility of transmitting electric power over long distances by high-voltage direct current has passed the experimental stage and is waiting for development. By this means it should be possible to transmit large blocks of energy economically for perhaps a thousand miles by underground or submarine cable and thus link consuming centres with new and distant sources of hydro-electric power. There is, too, the interesting possibility of linking the British and European Grids and thus securing a better balance between capacity and requirements by taking advantage of the seasonal variations in capacity and the diversity of demand. Such a scheme would, of course, be complementary to the distribution of power by alternating current, and it offers an opportunity for the British to share in European co-operation without raising the delicate problems of supra-national authority. A link of 250,000 kW. capacity should be of mutual service to both sides by providing the equivalent of a large modern generating station as stand-by plant.

The tides in favoured spots are obvious sources of energy, and, if more courage had been shown in pre-war years in carrying out schemes like the Severn Barrage, they might to-day be economical and saving fuel.

Then, it is tantalizing to think of the immense amount of energy reaching the earth by solar radiation, and the small use we make of it. The energy reaching the earth's surface is some 50,000 times as great as our consumption. Forty per cent of it is used in evaporating water and one per cent in lifting it into the atmosphere, whence we derive our water power. Most of the rest is absorbed and lost by radiation in the night. One per cent of the radiation falling on vegetation is used in photosynthesis, whence we derive our food and fuel. Many experiments have been tried to make more use of solar radiation—its concentration by mirrors to give high temperatures, its storage in hot water or melted salts, and the generation of electricity by the photo-electric cell or thermocouple. None has so far produced an economic solution, but sunshine is so often available at places remote from other energy sources that we urely have a duty to posterity to pursue long-erm researches in this field while we are living on eserves.

One large-scale experiment in using solar radiation s being made by the French Government on the west coast of Africa. A turbine will be driven by team obtained by evaporating under vacuum the warm surface water of the sea at 28° C., the condenser eing cooled by water at 8° C. drawn from a depth f 400 metres. Another interesting possibility, in Egypt, is to drive turbo-generators in the Qattara Depression by water drawn from the Mediterranean forty-five miles away, relying on solar radiation to evaporate the water from the tail-race as it accumulates in the Depression.

Last year Sir John Russell spoke of the possibility of raising the efficiency of plant photosynthesis to produce more food in a given area. Experiments have shown that this is possible with certain algæ, but the land-grown plant supplies the structure of its own factory and draws its own raw materials from the air and ground. The use of algæ would be an industrial process, and the land-grown plant may prove to be the more economical in operating costs. However, the work on algæ is in its infancy, and it would be premature to speculate about its economy.

Mayer ended his short prophetic paper in 1842 by saying that the inefficiency of the steam engine justified the attempt to produce 'motion' by other means than the sacrifice of carbon and oxygen, for example, by electricity obtained by chemical means. An economical fuel cell in which the free energy of the oxidation of carbon is converted into electricity has so far evaded discovery, but it remains one of the long-distance goals of research.

Nuclear Energy

The story of nuclear energy shows what can be done if science is used lavishly with all the resources of the modern world to penetrate Nature's secrets. Now, having wrested Nature's secret from her, comes the task of using her great storehouse for the good of man. I need not dwell on the advantages of that concentrated source of energy, with a potential several million times that of coal, if it could be tamed. Energy could be taken to remote places of the earth when it is needed. Deserts lacking only water might be made a paradise. But to-day the unsolved problems of these peaceful uses loom so large. Once more we see how hard it is to be creative compared with the ease with which man can destroy.

It is clear from the discussion at the Fourth World Power Conference, held in London this year, that the difficulties to be overcome before the use of nuclear energy becomes economical are most formidable, and their solution will require intense effort over a long period. New engineering materials must be found with properties never before investigated or required. They must be stable over long periods under intense neutron bombardment and must not cause loss of neutrons by absorption. The removal and disposal of the radioactive products from the reactors will be a costly and puzzling task. With the world's need of energy, it would be a tragedy if the fear of competition from nuclear piles were to delay in any way the immediate development of the more conventional and better understood sources of energy. It may well be that the first use of fissile elements will be to transport energy to places far remote from other sources. Meanwhile, the nuclear plants are yielding good dividends in the radioactive isotopes they produce. These provide a most powerful new technique of research, which has given us both a new understanding of many of Nature's processes and new methods of production control.

Auto-Mechanisms

The by-products and radiations of these nuclear plants are so dangerous to life that their operation is only made possible by automatic controls. This brings me to the latest chapter in man's use of energy, the new science of auto-mechanisms, which can replace the human senses and control machines. These modern robots may seem to bring us nearer to the fear of "Erewhon" of the mastery of the machine; but, just as the machine was the saver of manual labour, they are substitutes for the drudgery of the human brain. To-day the energy of the electron is harnessed by photo-cells, by radar pulse and other means through valves and amplifiers to watch and act. Usually these devices are more accurate than the human senses, and their action in micro-seconds eliminates the slow reaction time of man. They leave an automatic record, too, of what they have done. But in claiming the superiority of these man-made mechanisms for their specific purpose over man himself, I must make one exception. No auto-mechanism has, I think, approached the delicate perception of the sensory organ with which chemists are so well endowed—"Their noses infinitely wise. Their minds being memories of smells".

In any task that they are set to do, these controls must be fed with information to tell them when to act and the result. For example, in drawing wire through a die at constant tension, the auto-mechanism must detect a change of tension and at once adjust the speed of reeling-up until it knows the standard tension has been reached again, just as the senses tell the muscles how far their task has been performed. There are even electronic mechanisms to simulate the performance of their own kind and say how well, or ill, they do the work for which they are designed.

Sometimes the task is not so simple and calculations are involved, and these the electronic computer can do much faster than the human brain; and there are calculating machines with electronic memories which can be set to make most complex calculations which would be impossible by human means owing to the time involved. These electronic computers can perform set tasks without ability to think. Errors may occur if a vacuum tube burns out or a switch fails to act, and now a new device enables them to detect such errors, locate them and correct their own mistakes.

This latest venture in the use of energy must have most far-reaching effects. These automatic controls and precision techniques, consuming almost negligible quantities of current, will save man-power and add greatly to the economy of production, thus reducing the quantity of energy required. In the future, one of the indexes of economic progress should be, not the energy used per worker, but the output of goods and services per horse power employed.

Energy and the Future

Now, as I near the end of my address, I wonder, have I claimed too much for progress—progress, that missing word among the Greeks? Have we replaced the Golden Ages by an Age of Steel? Has man's use of energy brought happiness or not? There is no yardstick that can tell us, in Priestley's phrase, whether the "greatest happiness of the greatest number" has increased. We see the contrast of man's swift advance in understanding Nature and the troubles of the world to-day. Is the myth of Dædalus for ever true? Sir Arthur Keith ends his "New Theory of Human Evolution" with the words: "In the clash and turmoil of this modern world we are hearing the creaking wheels of the machinery of evolution". Is it inevitable, as he concludes, that in this great revolution through which we are passing the old primitive enmity of nations, the urge to self-sufficiency, will grow stronger? What ground is there for hope?

Once more I turn to Carnot's essay for the answer. In 1824 he wrote: "Navigation due to the steamship has in a measure drawn together the most distant nations. It tends to unite the peoples of the earth as if they lived in the same country". His prescient eye had seen that energy would bring the world together. We see to-day the stirring of a new world consciousness that must in time bear fruit, a new awareness of the load the modern Atlas has to bear, the problems we must face: the growing strain of increasing population, the malnutrition and endemic sickness of perhaps half the world, the inequalities between the more forward and the backward peoples, the gradual depletion of resources and their unequal distribution, and, by no means least, the human problem of changing the way of life and outlook of many millions. The hope lies in man's new understanding of Nature's processes, in his more efficient use of her resources and in the growing recognition of the dependence of one nation on another. Wendell Wilkie saw this so clearly in his classic phrase: "to raise the standard of living of one man anywhere in the world is to raise the standard of living by some degree of every man everywhere in the world".

These problems are the challenge to the science and engineering of our time. Only they can solve them—if allowed, and if men's minds are bent on quest of plenty not on quest of power. That is the issue for the world to-day, a world so divided for the moment. The orderly solution of these problems must depend on a knowledge of conditions and the needs of each country, on a survey of its natural resources, its human geography, its economic structure and its capacity to produce and consume. The limiting factors will then appear, and the problems they present can be attacked in their priority. The over-riding importance of such surveys is slowly being recognized, and the technique of making them is under way. Much material of the kind has already been collected by individual countries, by industries and by the agencies of the United Nations. Eight years ago I wrote: "Unless all this information is brought together to a central point—a United Nations Economic Bureau—it will remain uncoordinated, with unknown gaps, and there will be no comprehensive picture which may serve as a basis for the processes of reconstruction which will merge gradually into the processes of international trade". That is still true to-day, and last September at Lake Success many speakers emphasized the need for such inventories of world resources so that each country might know the resources and potentialities of the rest. Only in this way can the natura wealth of the world, distributed in such an accidenta way, best be used to meet its ever-growing demands.

In all these plans energy will play a vital part. S often its availability will dictate the pattern o development. It may well be the limit, in Bacon' words, "to the effecting of all things possible" Throughout the ages it has been the key to progress and it has not lost its power. On man's wise use o energy depends so much the future of this trouble world.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

MATHEMATICAL NOTATION

IN his presidential address to Section A (Mathematics and Physics), Prof. E. H. Neville discusses mathematical notation.

The great contribution of the nineteenth century to the subject was the acceptance of the non-numerical variable. Evidence of the belief that the variable must be in some sense numerical survives in the name of the complex number, and is to be found also in early writings on matrices and on quaternions. Cayley speaks of "the matrix considered as a single quantity", and it was not until the matrix was presented as an operator transforming one set of variables into another that it had the individuality which qualified it to be the element of an algebra. The same sort of individuality was conferred on the complex number by Argand and Wessel to end the scandal of 'the square root of minus one'. The adventurous calculus of operations of the nineteenth century was chopped to death by logic, but not before the enlarged conception of the variable was firmly established.

Notation is not right or wrong, but only good or bad. The most irritating of notational misfortunes are those where we should all like a slight modification in a usage that has become classical. No one can doubt that if we had a free hand to-day we should have a symbol for the radial measure of one right angle, not of two; the economy would be incalculable. William Jones is not to blame, nor even Euler, for the evidence is cumulative and was not in their possession; now it is too late to make a change. The case of the gamma function is more complicated. Gauss' Πx is identical with Legendre's $\Gamma(1 + x)$, and there is no doubt that Gauss' argument is the more convenient: to quote Jeffreys, the 1 which Legendre took over from Euler is "a minor but continual nuisance". We can agree to Gauss' form of the function but not to his appropriation of Π; the notation $x!$, which is gaining currency, creates difficulties of its own.

If two symbols are equivalent it does not always follow that one of them is redundant, and however closely two functions are related there may be sound reasons for retaining symbols for them both; a mathematical sense of proportion is often exhibited in the play made with alternatives. The theory of elliptic functions needs both the classical notation K, iK' and the structural notation K_c, K_n for quarterperiods; we can seldom make the best of two worlds unless we can speak two languages. In the same theory, we cannot express satisfactorily the theorems which depend only on the period lattice and also the theorems which depend on the labelling of this lattice unless we have symbols both for the parameter c and for the modulus k, although c is only k^2. The most notorious illustration of this principle is the scalar product of two vectors; the physicist and the engineer need the product $ab \cos \varepsilon$; but it was sheer ignorance to suppose that Hamilton could have accepted this product rather than its negative as fundamental in his calculus.

The most far-reaching innovation in formal symbolism in the present century has been Einstein's summation convention, which reduces to manageable proportions the labour of applying the tensor calculus, and has effected great simplifications in the presentation of co-ordinate geometry, of vector algebra, and of the theory of determinants. This convention operates within the field of the traditional notation of mathematics. The really revolutionary change that has been taking place at the same time is the permeation of mathematics by the symbolism of logic. English mathematicians have learned from "Principia Mathematica" that this symbolism not only provides systematic abbreviations for phrases in perpetual use, but also compels a careful analysis of the assertions to be expressed and incorporates an inferential calculus which can lead to an immense economy of actual thinking; the notation for orders of magnitude carries out these same tasks in its own sphere.

While logical symbols are being used more and more in the older parts of mathematics, newer subjects are tending more and more to ideography. In topology, in group theory, and in algebra in the modern sense, theorems which would have been enunciated verbally in 1900 are now enunciated symbolically. The notation controls the emphasis, reduces a long-winded corollary to a brief formula, renders accessible regions which it would have been humanly impossible to explore with words alone. These developments belong to groups of specialists rather than to the whole community of mathematicians, but it is the freedom of the community from conventional restraints in the use of notation that has made it possible for the groups fully to satisfy their own needs.

MODERN DEVELOPMENTS IN CARBOHYDRATE CHEMISTRY

THE period between the two Birmingham meetings of the British Association in 1913 and in 1950 has been noteworthy for the surprising progress made in the chemistry of natural products. This has been specially marked in the carbohydrate group, and the main theme of Prof. E. L. Hirst's presidential address to Section B (Chemistry) is the development of the ideas and methods which have rendered possible the present-day knowledge of the structure of the simple and complex sugars. This knowledge, so widely spread in industry, biology and medicine are the ramifications of carbohydrate chemistry, is of vital importance for the solution of problems in many other fields of inquiry. At the time of the Birmingham meeting in 1913, progress in the chemistry of the simple sugars was retarded by lack of precise knowledge of ring structures, and only the most meagre information was available concerning the disaccharides and the polysaccharides.

New methods of attack were necessary, and the requisite pioneer work, which enabled the unsubstituted reactive hydroxyl groups of sugars to be rendered chemically inert without alteration of ring structure, was carried out in the St. Andrews laboratories by Purdie and Irvine. Oxidation of the fully methylated methylglycosides was then investigated and developed into a general method for the determination of ring structures. By means of this technique and ingenious modifications of it, such as the oxidation of the fully methylated aldobionic acids in the disaccharide group, the workers of the Birmingham school, under the late Sir Norman Haworth, in a comprehensive series of investigations, determined the structures of the stable methyl glycosides (later termed pyranosides from the six-membered ring present in the molecule), the furanosides and the important naturally occurring disaccharides and trisaccharides such as cellobiose, maltose, sucrose, gentiobiose and raffinose. In many cases alternative methods, analytical and synthetical, afterwards provided confirmatory proof of the accuracy of the results obtained by the methylation method. One of the most versatile of the newer techniques is oxidation by periodic acid, introduced by Malaprade for the oxidative degradation of glycols. Besides numerous important applications in the mono- and oligo-saccharide groups, this reagent is of special value in the study of the complex polysaccharides; for it can be employed to gain quantitative evidence of the presence of end-groups, and, by examination of the hydrolysis products obtained from the oxidized polysaccharide, information can be obtained concerning the mode of linkage of individual residues in the polymer.

Another recent development of the greatest importance to carbohydrate chemistry is the use of chromatography for the quantitative separation of mixtures of sugars, whether unsubstituted or in the form of their methyl ethers. So delicate and accurate has this technique become that for the time being a limiting factor in the study of the complex carbohydrates resides not so much in the separation and classification of the various sugar residues as in the difficulty encountered in hydrolysing the polysaccharides without damage to the component sugars. Besides applying these methods to the undegraded polysaccharides, present-day investigators attempt to simplify their problems by examining the structure of degraded fragments obtained by partial hydrolysis.

In those ways, aided also by highly specialized physico-chemical techniques such as X-ray analysis and sedimentation in the ultracentrifuge, sufficient information may be gained on which to base the general structure of a polysaccharide. In some cases, for example, cellulose, which consists essentially of long chains of β-1,4-linked glucose residues, the structure is known in some detail; but even here there remains a fine structure of great importance to the industrial chemist about which little is yet known. The main structure of the amylose component of starch (α-1,4-linked glucose residues) is also known with some certainty. Much still remains to be learned concerning the amylopectin component of starch with its many branched chains and five per cent of its glucose residues present as end-groups.

Reference has been made to the special problems presented by the xylans, arabans, pectins and alginic acid, and it has been pointed out that, difficult as all these problems are, they are simple in the sense that each polysaccharide contains only one kind of sugar residue. The plant gums and mucilages and many polysaccharides of importance in chemotherapy present much more complex problems in that they contain a variety of sugar residues, and it is therefore necessary to ascertain the order in which these are united together in the molecule. Only a beginning has yet been made with structural studies on these groups, and Prof. Hirst concludes with a review of the position now reached, with special reference to the chemistry of gum arabic.

STONY METEORITES

DR. W. CAMPBELL SMITH, in his presidential address to Section C (Geology), points out that among the thirteen hundred or so known meteorites recorded in the past hundred and fifty years, some seven hundred and sixty are 'stony meteorites' consisting mainly of ferromagnesian silicates. The elements found in meteorites do not differ from those known on the earth, and the silicate minerals of the stony meteorites are varieties of the same species as those found in basic and ultrabasic igneous rocks.

About ninety per cent of all stony meteorites contain varying proportions of nickel–iron, ranging from 4 to 25 per cent, and these (with half a dozen exceptions) are characterized also by the presence of small, spherical bodies ('chondrules') consisting of pyroxene or olivine, or both together. These meteorites are called chondrites. Their chondritic structure and nickel–iron content make them quite unlike any known terrestrial rocks. The remaining ten per cent of stony meteorites, containing no chondrules, are called 'achondrites'. Some of these show a partial resemblance in mineral composition and texture to igneous rocks. By applying to them the methods used in the study of igneous rocks and rock-forming minerals, we may hope to obtain some insight into the conditions under which meteorites were first formed and what changes they have since suffered.

One group of the achondrites, the eucrites and howardites, represented by about twenty-five falls, comprise meteorites of which the constituent minerals are feldspar (bytownite–anorthite) and pyroxene (mainly pigeonite). They are, with one exception, intensely brecciated; but they contain many fragments which resemble in texture some ophitic dolerites and basalts, and these are regarded as products of direct crystallization from molten magma.

The other achondrites contain little or no feldspar, consist of magnesium–iron–pyroxenes and olivine, and, except when brecciated, present a holocrystalline granular texture. Their mineral assemblage falls almost wholly within the $MgO–FeO–SiO_2$ system fully investigated experimentally by N. L. Bowen and J. F. Schairer. The conditions of crystallization of the several phases in this system show that one cannot explain the crystalline granular achondrites as the result of direct crystallization from a magma of their own bulk composition. They must be regarded rather as the result of crystal-settling in a differentiating magma. Such a process requires not only bodies of magma of considerable size but also a gravity field sufficient to make settling of crystals in a magma possible. Both requisites imply that the material of these achondritic meteorites formed within a body comparable in size with our earth.

A similar settling of magnesium silicate minerals, but mixed up in some way with nickel–iron, may account for the original materials of the chondritic meteorites; but their subsequent changes in composition and structure, resulting first in a transfer of iron between nickel–iron and silicates, and later in the formation of chondrules, are more difficult to explain. G. T. Prior found, as a result of a survey of the chemical composition of stony meteorites, that "the less the amount of nickel–iron in chondritic stones, the richer it is in nickel and the richer in iron are the magnesium silicates". Prior attributed this relationship to progressive oxidation of metallic iron acting for different periods or at different rates. One must suppose that such reactions proceeded in bodies of considerable size which had, owing to different conditions, varying opportunities for interchange between metal and silicate. Such different conditions may imply that the bodies were separate and travelling on different paths. However this may be, the resulting silicates of the chondrites correspond to only part of the achondrite series, ranging from pure enstatite to the hypersthene–olivine assemblages with MgO : FeO from $2\frac{1}{2}$ to 4. The more ferriferous magnesian silicates are not represented among chondrites, and nickel–iron is never entirely absent from them.

The chondrules, whether of orthopyroxene or olivine, appear, so far as available evidence goes, to have compositions similar to those of the silicate minerals with which they are found. This implies that they were not formed until after the silicates had reached their present composition.

Many theories have been advanced to explain the formation of chondrules. Some, consisting of radiating enstatite prisms, appear to have crystallized rapidly from globules of molten pyroxene; others with porphyritic and granular olivine crystals in a glassy fine-grained base may have crystallized more slowly from larger parts of the mass which were thereafter broken up and rounded by attrition while still soft. The conditions for their formation may have developed when the course of the bodies broken from the parent planet passed near the sun, which caused intense heating and violent fusion accompanied by ejection of molten globules. After cooling became possible, the chondrules must have been gathered back into the mass from which they came, for the meteorites now consist of chondrules in a matrix of broken fragments of pyroxene and olivine, and of broken chondrules as well, with varying amounts of nickel–iron and troilite, the whole forming a compact though sometimes friable stone.

Subsequent to the first crystallization of the achondrites and later than the formation of chondrules in the chondrites, there occurred, in most stony meteorites, intense brecciation, re-heating (sometimes repeated) and the formation of thin black veins which have been compared to the pseudotachylyte veins found in some great granite masses and attributed to crushing in bodies of rock of considerable size. In the case of the chondrites, these effects must have taken place after the break-up of the parent planetary body. There may have been more than one period of break-up, and one must be prepared to consider, as a possible cause both of brecciation and re-heating, violent changes of temperature due to passage close to the sun of masses still of considerable proportions. The final break-up into meteorites of the size known to us from actual falls came at a still later stage.

None of the structures here described is attributable to heating effects caused when meteorites enter the earth's atmosphere. These are restricted to the 'burning away' of the outer part of the meteorite, disruption with explosive violence, the formation of the peculiar pittings ('thumb-marks') and, last of all, the solidification of a thin glassy crust coating the surface of the stone.

THE SCIENCE AND PRACTICE OF ENTOMOLOGY

ENTOMOLOGY in Great Britain remained for long enough the care of amateurs, and when the scientific teaching of zoology in the universities was being established during the second half of the last century, the insects were largely neglected. That was unfortunate, because the insects compose a majority of the known species of animals; they are exceedingly diverse in form and habit and well suited to illustrate, often in the most vivid form, most of the problems with which the student of living things is concerned. Indeed, at the present time, insects are being used to an ever-increasing extent as a medium for study by chemists and physicists, geneticists, experimental zoologists, physiologists and biochemists; above all, they furnish exceptional material for the study of animal behaviour and ecology. In his presidential address to Section D (Zoology), Dr. V. B. Wigglesworth discusses "The Science and Practice of Entomology".

The period during which zoology became established in the universities of Great Britain was also a period of rapid development in large-scale agriculture and of improvements in communications, with the consequent emergence and dissemination of insect pests. The change was heralded in the 1860's by the transformation of the harmless Colorado beetle into a major pest of agriculture, sweeping across the American continent and, to-day, across Europe. The production of Paris green as an agricultural insecticide was the result, and since that day the insect pests of agriculture have become ever more prominent and the insecticides and other methods of control more powerful. During this same period we have become increasingly aware of the importance of insects in carrying disease to man and his livestock, in consuming large quantities of our stored foods and other produce, and in destroying structural timbers. The insects have surely come into their own—in both pure and applied science.

If this field of science is to be exploited to the full, we must turn out entomologists who know the world of insects in the round; who are at once morphologists, taxonomists, physiologists and field naturalists. These men will find that the world of insects is in a state of flux; that the species tails off into the 'biological race', that species are continually changing in abundance and, apparently, in habits and certainly in the amount of damage to human interests they bring about. It follows that the applied entomologist must be constantly investigating, that *applied entomology is research.* Once a problem has been solved, the preventive procedure can often be incorporated into the practice of the industry in question and the entomologist is no longer required. He will always be confronted with new problems for solution and must therefore always retain the outlook of the investigator.

This thesis has important implications in the field of practice and administration. The dissemination of existing knowledge in the form of advice by the applied entomologist is not enough. Existing knowledge is too inadequate. In all the fields—agricultural entomology, insect pests in stored products or in timber, the locust problem, and the rest—we need an unbroken chain of research workers at all levels from the theoretical to the practical; and the entomologists at the most practical end must be shielded from petty incursions upon their time, so that they may get on with their proper work of investigation. For the entomologist in the Colonies there is the added need for contact with libraries and centres of research in Britain and elsewhere if the stimulus to investigation is to be maintained.

But is entomological research still necessary in the applied field ? Or is the entomologist, in fact, outmoded by the discoveries of the organic chemist in the realm of insecticides ? The discovery of the insecticidal properties of DDT, 'Gammexane' and the organophosphorus compounds respectively in Switzerland, Great Britain and Germany has transformed the control of insect pests during the past ten years. But it is becoming increasingly evident that the use of more and more insecticides is creating insect problems as fast as it solves them. We can probably control any specific orchard pest, for example, with which we have to deal—but the problem of orchard pests in general gets worse. There is, in fact, increasing scope and need for entomological research—to guide intelligently, to supplement, and sometimes even to supplant the application of chemical measures of control by the more subtle and more remunerative methods of biology.

THE UPLAND PLAINS OF BRITAIN : THEIR ORIGIN AND GEOGRAPHICAL SIGNIFICANCE

PROF. S. W. WOOLDRIDGE surveys some of the problems of the later stages of landscape evolution in Britain, and particularly the evidence afforded by well-marked erosion surfaces developed over a wide range of altitude, in his presidential address to Section E (Geography). Though much work has been done on these surfaces both by geologists and geographers, the evidence as a whole has not yet been faced, nor general conclusions proposed. It is clear that no adequate reconstruction of the stages of development of the British land-surface can ignore such evidence ; the partial explanation frequently proposed tends to hark back to older structural episodes which are, in fact, largely irrelevant to the question.

The key area is south-east England, where a widespread surface of marine planation at about 600 ft. retains traces of a cover of known (Newer Pliocene) age. Above it, the summit areas retain remnants of an earlier peneplain, while at lower elevations there are extensive remnants at about 400 and 200 ft. O.D. respectively, the former being evidently of late Pliocene or early Pleistocene age. The Bristol district exhibits remnants of upland plains at the same three altitudes and also at 750–800 ft. In east Devon the sequence of surfaces is fuller, as shown by J. F. N. Green, who distinguished six 'platforms', interpreted as marine strand-flats, between 500 and 1,000 ft. O.D. The evidence is continued farther west in Devon and Cornwall, where platforms at about 1,000, 800 and 400 ft. have long been known. The west-coast areas from Cornwall northwards to Cumberland, and parts of the Irish coast, reveal a closely similar succession of platforms, and there are indications of the occurrence of some of them in Scotland. No similar evidence is available from the east coast of England, the region having presumably suffered tilting or warping towards the North Sea depression. Over much of the rest of the country, however, there is evidence of long-continued stability, involving either uniform uplift of the land or a spasmodically sinking sea-level.

It is concluded that the major platforms up to a height of 1,000 ft. are, in general, of marine origin and not older than Pliocene in age, though the higher summit planes of the Welsh mountains, Pennines, etc., most probably represent surfaces of sub-aerial planation of earlier Tertiary date. The acceptance of these conclusions carries important implications for geophysics and stratigraphical geology, as well as geomorphology. In the latter field, they afford an outline of a coherent story of the earlier stages of coastal evolution and throw much light on the development of river systems. Further, it is manifest that if the several 'upland-plains' of Britain represent surfaces exposed for periods of differing duration to soil-forming processes, physiographical analysis is vitally relevant to the study of soil character, and therefore of considerable importance to the plant ecologist as well as to students of land utilization and land classification.

ECONOMIC PROGRESS : RETROSPECT AND PROSPECT

IN his presidential address before Section F (Economics and Statistics), Prof. G. C. Allen points out that statistical investigations, as well as common observation, show that a great advance in income per head took place in Great Britain in the half-century before the Second World War. Even in the years between the two World Wars, which are often mistakenly looked upon as years of stagnation, there was probably a rise of about 25 per cent in real income per head. The main cause of this improvement was the growth in industrial productivity ; it has been estimated that, between 1907 and 1937, output per man-hour grew by more than 80 per cent in real terms, and most of this increase occurred after 1924.

It was this experience which led to the optimistic forecasts of our economic future that were made shortly before the end of the Second World War. Our troubles since 1945 have, however, produced a more gloomy mood, and this has been intensified by the results of various inquiries which have revealed weaknesses in our industrial capacity, especially in comparison with that of the United States. Many of these weaknesses have been attributed to our unsatisfactory or obsolete equipment, and it is commonly asserted that they can be removed only by greatly increasing investment in our under-capitalized industries. While capitalization and productivity are, of course, very closely linked, it is doubtful if the above diagnosis is entirely adequate ; for our productivity is lower than that of some other countries, even in industries in which there is no wide disparity in the amount of capital used per worker.

A deeper cause of our inferiority, it is suggested, is to be found in defects in our use of the resources already available to industry, and this means a failure of industrial leadership. It is fertility in resource and imaginative enterprise that lie at the roots of material progress. The backward countries of the world are in that position not so much because they lack capital as because they lack industrial leaders. In a country like Great Britain, which cannot now lay claim to any superiority in natural resources over many others, and which is being overtaken by numerous competitors in the old-established industries, it is the capacity to carve out new channels of enterprise upon which material progress will depend. The most disquieting feature of the inter-war situation was not that our old industries, in which we were once supreme, declined, but that we did not achieve a foremost position in the new industries that appeared during that time.

The chief contribution to material progress in the future is likely to be made, as it was made in the past, by the industrial leader who uses resources for *new* productive purposes, and whose massive innovations force the ordinary run of business men out of their routine and so raise the level of efficiency throughout an economy. A society which impedes this kind of activity on the part of the innovators cannot hope for great improvements in its material standards. In recent decades Great Britain has lagged behind other nations in industrial leadership. Our position in established industries has been undermined by developments that took place abroad rather than at home, and, in spite of our scientific achievements, we have not shown the capacity of our fathers, or of the industrialists of some other countries, in creating new industries. Since our progress in material well-being in the decades ahead is likely to be substantial only if we show exceptional competence as industrial pioneers, this is a cause for grave concern.

It may be that the day of the private entrepreneur, in his role of innovator, is over in Great Britain, and we have to ask whether his function can be performed by some other agency, for example, by the State. In some of the more primitive countries, governments have certainly performed this function with success. But, in those countries, the task has been that of introducing techniques and forms of organisation already worked out elsewhere. Whether governments can be equally successful in developing entirely novel kinds of industry within advanced societies has yet to be shown. Success depends largely upon the selection of the right men for responsibility; and those who in the past have done most for the world in this field have had to work their own way to the light, often in the face of opposition or scepticism on the part of their well-established contemporaries. New industries, for example, have not normally sprung from large, established concerns, but have usually been built up from small beginnings. The government cannot easily select the right men when they are still unknown and untried for heavy responsibilities, and yet it is from such men that great industrial innovations have usually come.

In the end, whether it is left to the government or to private entrepreneurs, successful innovation has, as its first condition, the existence of a society which welcomes it and which is sufficiently cohesive to withstand the disruption of old ways of life that innovation causes. Whether any particular society possesses the morale which makes it possible to preserve social stability in the face of far-reaching technical changes, just as whether it possesses the energy and will which drive forward a people in the pursuit of material progress, are questions that cannot be considered primarily in the context of economic calculation.

A CHAPTER IN BRIDGE ENGINEERING A CENTURY AGO

PROF. A. ROBERTSON begins his presidential address to Section G (Engineering) with the reminder that a hundred years ago, in March 1850, the Brittania Tubular Bridge was opened. In the previous year the report of the commissioners appointed to inquire into the application of iron to railway structures was published. Both are notable instances of the collaboration of engineer, constructor and mathematician which has been so fruitful in engineering. The Bridge was an impressive advance on previous work, not only in size but also in the material of which it was constructed and the manner in which it was erected. In order to complete the Chester and Holyhead railway, the Menai Straits had to be crossed. By making use of the Brittania Rock, the longest span could be kept down to about 470 feet. Robert Stephenson's original proposal of a cast-iron arch (which would have been twice the span of any existing arch) was rejected, and an Admiralty commission demanded a clear passage throughout the whole span of a hundred feet above high water.

Stephenson conceived the idea of a tube (through which the train would pass) which might need to be supported by chains during erection and possibly retained as a permanency. Such a bridge would have to be in wrought iron, although the longest wrought iron bridge at that time was only about sixty feet. He decided on a series of experiments which he placed in the hands of William Fairbairn, who later called in Eaton Hodgkinson. Tubes of 12–24 in. in diameter and 25–31 ft. long were made by rolling sheet to a thickness of 0·037–0·135 in. and then riveting. They were tested in bending by a central load. The tests brought into prominence the phenomenon of wrinkling, that is, the portion under compression failed by crumpling up into folds. Further tests were done on elliptical, square and rectangular tubes. It was decided to build a model one-sixth full scale, 75-ft. span, having a cellular top (compression side) and a single plate for the bottom. The model was tested under a central load. In the first test it fractured under 35·5 tons. Alterations were made, and in the final test the load was 86 tons, corresponding to a stress of 14·8 tons per square inch on the compression side and 18·6 on the tension side.

The final design for the bridge consisted of a series of cells for both top and bottom booms, separated by side plates which were stiffened with vertical angle-iron and gusset plates. The cellular construction was necessary because plates could not be obtained thicker than ¾ in. The tubes were constructed on stages built on the shore, so placed that pontoons could later be brought underneath the tube. The first tube (412 ft. long, and actually that for the Conway River) was proof-tested with a load of 300 tons over the middle 300 ft. In order to devise the best way of navigating the pontoons on which the tube would be carried from the shore to the site, a model of the Straits was constructed and the position of the necessary winches, etc., was settled. On reaching the site, the pontoons were released and the tube rested on the masonry of the base. The tube was raised to its correct height by means of long chains depending from hydraulic presses fixed in the towers. The several spans of the Brittania Bridge form a continuous girder, and this advantage was used when the tubes were finally joined together.

The cellular construction devised for the bridge was adopted by Brunel in 1854 for his ship the *Great Eastern*, which in displacement was five times that of any vessel then being built and fifty years ahead of her time. Structurally she was a great success.

Before the Britannia Bridge, most railway bridges were built of stone, brick, timber or cast-iron. For many of the short ones, cast iron was used as a beam, and for some (up to about a hundred feet long) several castings were bolted together. Sometimes these were designed with a trussing of wrought-iron tension bars. The failure of a bridge of this type led to the appointment in 1847 of a Royal Commission. The important clause in the terms of reference was: "They shall endeavour to ascertain such principles and form such rules as may enable the engineer and mechanic, in their respective spheres, to apply the metal with confidence and shall illustrate by theory and experiment the action which takes place under varying circumstances in iron railway bridges which have been constructed". This clause excited considerable opposition among the engineers of the day who feared the possible formulation of rules to be observed.

The Commission concerned itself almost entirely with cast iron, and deliberately refrained from expressing any opinion on wrought iron. It instituted a series of valuable experiments on such varied topics as: the repeated application of load with and without impact, the effect of a slowly moving weight applied many times (96,000), and the effect of a weight moving with velocity over a beam. The whole report represents an extraordinarily fine achievement for less than two years work, since it contains the first experiments on many subjects of vital importance to engineers. Except for Fairbairn's experiments on wrought-iron built-up girders in 1860–61, nothing of importance was published on the resistance of metals to repeated loadings until Wöhler's classical work in 1870.

INFLUENCE OF FOOD PLANTS ON SOCIAL STRUCTURE

DR. REDCLIFFE N. SALAMAN'S presidential address to Section H (Anthropology and Archæology) is concerned with the social repercussions in Britain of one of the latest food plants, namely, the potato; for man's first need is food, and its character and acquisition largely determine his way of life.

The potato reached Spain about 1570 and the British Isles during the last decade of the sixteenth century. For the next hundred years in the south and midlands of England it remained a luxury raised in the kitchen gardens of the great houses. In the north its advance was more rapid and deployed over a broader social base. This difference was in the main due to the absence of the open field and the greater economic freedom of the workers in the north, created by competition between agricultural and mining interests. From about 1700 onwards the potato was eaten because it was liked, not because it was necessary.

In the south and midlands the cultivation of the potato was much slower and followed a different course. In general, the working classes ignored it. About 1725, market gardens sprang up outside London and the middle classes became interested in the new food. In 1778 the London retail price was ½*d.* a lb., or one-eighth the price of meat. In 1939 it was one-eighteenth, which partly explains why the tuber was not adopted earlier by the lower-paid town workers.

After the turn of the eighteenth century, farmer and labourer began to take an interest in the potato, first feeding it to their pigs and horses, and only when it was obvious that it did not poison them was it included in their dietary. On the evidence of Arthur Young, so late as 1784, the potato had made little progress in the homes of the rural workers. Prior to 1750, workers had been satisfied with a mixed wheat and barley or rye and barley loaf, while the well-to-do enjoyed a white wheaten one. A change gradually took place; the brown loaf was discarded and with it the social implication following the use of two standards in respect to the staple of life.

War and the disastrous harvests of 1794 and 1795 caused the price of the quartern loaf to rise in twelve months from 7*d.* to 1*s.* 1*d.*, and later to reach 1*s.* 5*d.* Wages showed no appreciable rise for some time and never fully covered the rise in the cost of living. In 1770 the average worker's daily wage could purchase two loaves, in 1780 one and a half, in 1800 four-fifths of a loaf, and in 1810 a whole one; not until 1850 could it acquire the same amount of bread as it had in 1770. To meet the crisis workers were invited to return to the mixed loaf or accept a potato and wheaten loaf; both were refused. After great privation, a compromise was found by the adoption of the potato as a major article of diet. The economic effect was deplorable. The cost of living was lowered and wages stabilized at the lowest possible standard. Other factors undoubtedly helped to make the lives of the workers so incredibly sordid during the first half of the nineteenth century, but none was more insidious than the potato.

The influence of the potato in England is the merest reflexion of that it wielded in Ireland. Its arrival coincided with the later stages of a long and devastating war. To a starving peasantry, literally without home or property, came this heaven-sent food. As easy to grow as to hide from the military, satisfying and palatable, its future was never in doubt. Probably in little less than a century it was the native Irishman's main, and sometimes his sole, source of food. Such a dominance is almost unique in man's long history. By fostering unlimited procreation, the potato decontrolled the size of the family, dictated the routine of work, the tenure and use of the land, and the amenities of the home. A monophagous peasantry with the lowest standard of living in Europe afforded unlimited scope for exploitation, socially, politically and industrially. The opportunity was not neglected in eighteenth-century Britain.

In the nineteenth century, when a far better understanding existed between the two countries, the destruction by blight of the potato crops in 1845 and 1846 led to a disaster without parallel until recent days. Nevertheless, so firmly established was the habit that, in relation to the size of the population, the acreage under potatoes actually increased in the post-famine years. The history of the Irish people is in no small degree that of its subjection to a potato dietary.

HORMONES OF THE DIGESTIVE TRACT

A BRIEF summary of the chief discoveries which have led up to our present knowledge of the intrinsic hormones of the digestive tract is outlined by Prof. R. J. Brocklehurst in his presidential address to Section I (Physiology). This system of local hormones, all probably related to proteins, found in the upper part of the abdominal portion of the alimentary tract, is unique in that the active substances, released from certain parts of the tract, act on digestive organs in the near neighbourhood, without apparently having effects on remote parts of the body, such as occurs with the hormones secreted by the endocrine glands. So far as is known, the alimentary tract hormones are not discharged into the blood as a result of nerve stimulation; most of them are released as a result of the contact of substances in the gastric or intestinal contents with the mucous membrane, and the prolonged effects which they produce are limited to the period of such contact. There is evidence that some, at least, of them are destroyed fairly rapidly in the blood.

The elucidation of these hormonal mechanisms has been carried out in the main with the help of ingenious operative procedures specially designed to demonstrate the responses of particular organs, freed, so far as possible, from complicating factors such as their nerve supply. These procedures have included the formation of pouches of the two main parts of the stomach, fistulæ of the small intestine, the transplantation of pouches and glands to subcutaneous sites where they obtain a new blood supply, and the technique of cross-circulation.

Three humoral factors are concerned in gastric digestion. Gastrin is a substance which is released from the mucous membrane of the pyloric part of the stomach when certain food substances come into contact with it; it travels by the blood-stream to the body of the stomach and there stimulates the secretion of acid gastric juice. Much research has been carried out with the purpose of deciding whether gastrin is the same as histamine, a powerful acid-secreting stimulant known to be present in the stomach; but, as active gastrin preparations containing no appreciable quantity of histamine have been prepared, it now seems likely that they are separate substances. A second humoral stimulant of gastric secretion is a substance liberated from the mucous membrane of the small intestine when the contents of the stomach pass into the latter. Little is known about its nature.

Gastric digestion is retarded by a substance, enterogastrone, which is liberated when fats enter the small intestine and which has an inhibitory action on both gastric secretion and gastric motility. There is a definite possibility that these activities may be due to two distinct substances.

The secretion of pancreatic juice is stimulated by a double hormone mechanism. Secretin, the first alimentary hormone to be discovered and investigated, is discharged into the blood when dilute acid, bile salts or certain other substances come into contact with the mucous membrane of the duodenum and upper small intestine. It evokes a secretion which is mainly an aqueous solution of bicarbonate and which has a low enzyme content. It is an important link in the self-regulating process whereby the hydrogen-ion concentration of the former gastric contents becomes reduced to a level suitable for the action of the pancreatic enzymes. The hormone can be extracted in greatest amounts from the duodenal mucosa, and in decreasing quantities as the small intestine is followed downwards. Secretin preparations are now in use on human patients for diagnostic purposes.

The enzyme output from the pancreas is markedly stimulated by a second hormone, pancreozymin, from the same source, which itself has no influence on the volume of the juice secreted. By these two means pancreatic juice, complete with its enzymes and bicarbonate, is produced when chyme enters the small intestine from the stomach.

Secretin also stimulates the rate of bile secretion by the liver, though not so effectively as bile salts. A closely related hormone, cholecystokinin, also promotes the entry of bile into the small intestine by raising the tone of the gall-bladder muscle. It is discharged into the blood when fats reach the duodenum and is an important factor in indirectly facilitating the digestion and absorption of fats.

There is evidence that intrinsic hormone mechanisms play a part in the stimulation of the glands of the small intestine, and so are partly responsible for the secretion of the succus entericus. The evidence at present suggests that there may be two such hormones, one of which acts specifically on Brunner's glands in the duodenum. It has also been claimed that another intestinal hormone is concerned with the muscular activity of the small intestine villi.

HUMAN AFFAIRS AND THE PSYCHOLOGICAL POINT OF VIEW

THE point of view of a science, as Dr. J. C. Flugel indicates in his presidential address to Section J (Psychology), has some significance apart from the knowledge that has resulted from the practice of the science: the scientific point of view depends upon the adoption of a predominantly cognitive attitude or 'set' in which wishful or 'autistic' thinking is rigorously subordinated to the search for truth; the different sciences result from the adoption of this point of view with regard to different, more or less arbitrarily distinguished, categories of phenomena. Psychology results from its adoption towards the phenomena of 'mind' and of 'behaviour'—a field where this adoption has some special significance in virtue of the fact that here, even more than elsewhere, we are liable to be influenced by emotional and moral considerations rather than by objective cognitive judgment. The full significance of the psychological point of view can best be realized when we consider the impact of psychology on certain other disciplines and the conflicts between the contrasting points of view involved in such cases.

Psychology split off from philosophy very largely on account of the adoption of the empirical method of systematic observation and experiment which it endeavours to take over from the physical sciences. As a consequence of this, in its modern developments it has stressed the affective and 'orectic' aspects of mind more than the purely intellectual processes of knowing which were of chief interest to the philosopher. In this way, in describing the actual processes of thought, it has in turn corrected the over-intellectualistic approach in the older treatises on logic. The old problem of determination it short-circuits by accepting motive, choice, decision, etc., as subjects which can be studied by the methods generally applicable to the inorganic sphere.

Medicine is another parent discipline from which psychology has sprung. Here the conflict lies chiefly with the materialistic point of view, though in modern psychosomatic medicine mind and body are treated on an equal footing. A greater realization, however, of the fact that many of the ills of the mind are no more under direct voluntary control than are the disorders of the body would produce a great alleviation of shame and encourage earlier resort to psychotherapy when it might be most effective.

There is much room for a closer psychological approach to economics, where the processes of saving and spending urgently call for a study of motivation on lines which, applied to production, are proving of great value in industrial psychology. In education psychology is already well established, but the increasing penetration of the psychologist into the field of delinquency has revealed a very significant conflict with the legal and moral points of view; and the latter conflict also plays its part in the relation between psychology and ethics, where the old problem as to whether values are subjective or objective has been rendered more acute by psychological studies of the processes of moral development and moral evaluation. Somewhat similar problems have been raised by the psychological approach to æsthetics, though the conflict is perhaps still more acute as regards religion, where the psychological investigation of the religious attitude and its development has appeared to constitute a threat to theological beliefs, although, at the same time, psychology has itself corroborated the great significance of the affective factors that enter into religion. Perhaps the most urgent need for a greater adoption of the psychological point of view is in the field of politics, where existing 'social psychology' has as yet had little actual contact with grim political realities, although psychological studies of some of the mechanisms at work—for example, ambivalence, displacement of affect, projection, splitting—certainly merit more attention than they have received from those who control the destinies of people.

Finally, as regards man's use of energy, which is the main topic of this meeting of the British Association, the human direction of physical energy depends ultimately upon man's use of the energies in his own mind, and it is only psychology which can teach him the nature of these energies and the methods possible for their direction. Hence, a very grave responsibility rests on the psychologist.

MODERN TRENDS IN THE CLASSIFICATION OF PLANTS

DR. W. B. TURRILL'S presidential address to Section K (Botany) reviews briefly some reasons for the relative neglect of plant systematics in recent times, particularly in universities. Taxonomists have tended to be too rigid in principles and methods; the rise of other branches of botany has captured the imagination of students; the subject is not easy to teach adequately; and there has developed the vicious circle of few or no teachers and few students with a bent towards systematics. There are signs that the position is changing. Gross morphology still provides the main basis for classification of the approximately 250,000 species forming the seed-bearing flora of the world; but methods of collecting, of analysis, and of description have improved and recent monographs and floras illustrate these improvements. Still more important has been the introduction into taxonomy of data, methods, and principles from other branches of biology, which may lead from classifications based on superficial characters towards an ideal classification which shall bring together all possible knowledge of plant life. The impact of the new points of view is considered in some detail.

Anatomical structure, particularly at the family-level, is correlated to a high degree with gross morphology. The recently published work by Metcalfe and Chalk, "The Anatomy of the Dicotyledons", provides much new information. Similarly, the biochemistry of plants often provides taxonomic data from the occurrence of volatile oils, alkaloids, glycerides and other chemical products. Cytological data can throw much light on taxonomic problems, especially at about the species-level, by providing additional characters and by indicating with greater or less certainty the origin of this or that taxon. Some new problems have, however, to be faced by taxonomists as the result of cytological investigations. They have, for example to consider the treatment of polyploids within what has been considered a species unit. From ecology, taxonomists can expect help in delimiting stable units. Autecological studies are of great importance, and experimental ecology by such studies as those of the transplant experiments at Poltern and Kew, in California, and elsewhere, have already yielded valuable new facts for classification. Genetical research must be more closely linked with taxonomic studies if both are to progress satisfactorily. Long-range experiments with *Silene*, *Centaurea*, *Ranunculus*, and species of other genera show how genetical methods combined with those of taxonomy and ecology can solve many problems of systematics. Morphogenesis and organogenesis applied to taxonomic problems emphasize the value of considering full life-histories and past developments. Plant geography has to be based on taxonomy; but the mapping of ranges and distributions reciprocally helps with taxonomic difficulties. There is a great need of further research into the past history of the flowering plants by studies of fossils. Modern statistical methods are being gradually introduced into taxonomy; but special methods must be developed for problems peculiar to classification, and the taxonomists hope that statisticians will turn their attention to some of these.

Phylogenetic facts should be considered in preparing classifications; but most often general phylogenetic hypotheses have been based on classification, not vice versa. Recent papers by Sporne and Corner raise many questions regarding primitive and advanced characters and the course of evolution in the flowering plants. Entirely new methods and principles may yet be applied to plant classification. Hayata's so-called 'dynamic system', and the use of figure and letter symbols in place of orthodox nomenclature, at least within the species, are suggestive.

Training in taxonomy is now receiving more serious attention. The best approach is to teach the student to teach himself the practice of taxonomy, and to guide him to an understanding of the fundamental principles of classification. This double approach must be unified: principles become dogmas unless constantly applied to, and tested by, facts; merely to collect facts is to make bricks without building. Teaching in systematics must be mainly by practice, and the newer methods and outlooks considered in this address should be given prominence.

The potentialities of plant taxonomy are very great. Without classification no research is possible. Systematics is linked with all other branches of biology. Taxonomists desire to make their classifications more and more useful to all biologists. They work to serve and ask only for such recognition as they fairly deserve.

QUALITY IN AGRICULTURE

THE main theme of Prof. H. D. Kay's presidential address to Section M (Agriculture) is that the maintenance of a tolerable standard of living in Great Britain in the future will depend to an increasingly large extent on the quantity and quality of food that can be obtained from the limited home acreage. Though there is an appreciable area of poorer marginal land which, using modern methods of reclamation, could be brought into cultivation (though at considerable expense), it is clear that much more food per acre must be produced from the better land now being farmed. The average quality of British farming is far from poor; but there is still a considerable margin for improvement on most farms.

The official approach to this major problem—the important Agriculture Act of 1947 and the agricultural expansion programme of the same year—called for improved quantity and quality of products, and laid emphasis on better farm management and adequate application on the farm of the results of scientific and technological research. The agricultural expansion programme is an endeavour to meet the economic rather than the military vulnerability of Great Britain. It is a challenge, not so much to agricultural science as such, but to the science of getting existing knowledge applied as rapidly as possible to increasing the productivity of the large majority of the relatively small units of an inherently conservative industry.

The assessment of British farming quality and efficiency in terms of monetary values and profits has of recent years, in view of subsidies, other artificial fluctuations in financial returns and arbitrary changes in rates of exchange, lost much of its significance. Efficiency must now be measured in other terms. Production per acre of foodstuff of adequate quality, when compared against local or national standards of good husbandry, gives the basis for a better estimate, and one more in line with national needs, of the quality of the work of any given farmer, or group of farmers, and provides a standard for emulative effort.

Milk production is by far the most important of agricultural enterprises in Britain. At present, by whatever yardstick it is measured, production efficiency varies very greatly from farm to farm. It is now possible to propose reasonably quantitative standards for assessment of quality in dairy farming. The average dairy farm in England and Wales, with a cow population of twelve to fourteen, should, by using modern scientific knowledge and up-to-date management methods, be able to carry double that population with no loss, but rather an increase, in yield per cow. This would allow, on such a farm, for one other competent worker as well as the farmer to be maintained and adequately paid. In an average year, such a farm could be made almost self-supporting, given the necessary fertilizers from without. In the product, good keeping quality, freedom from pathogens and high nutritional quality denote also the 'quality' dairy farmer. It is of particular importance to maintain high nutritional value of milk; payment for milk on compositional quality would assist in this desirable objective.

With the substantially increased yields of milk per cow and per acre that science has now placed within the grasp of the competent dairy farmer, the 2,000 million gallons of milk per year for the United Kingdom, which the nutritionist calls for to meet national minimum requirements for liquid milk consumption, could be produced from a very appreciably smaller acreage than is the 1,750 million gallons produced at present. A steady move in this direction, with a concentration of dairy cows into specialist herds, should progressively liberate more good-quality land both for the home-grown cereal expansion programme and for providing more and better quality beef and other animal products. Methods for improving the quantity and quality of pigs and poultry, using home-produced feeding-stuffs only, are now known, and new methods are being investigated. The possibility of producing fodder yeast in Colonial territories abroad for supplementing pig and poultry rations at home requires further consideration and large-scale experiment, which would be likely to benefit both home and Colonial economy.

In improving farming quality, one of the most important needs is to give the large and increasing number of scientifically and practically trained young agriculturists, who have, under present inflated price conditions, little or no prospect of being able either to purchase or rent a suitable holding, a real opportunity to farm for themselves. Modern farming demands to-day a high level of scientific training and practical skill in its entrants, and must become in fact, if not in name, a chartered profession for which the same careful and thorough preparation is required as for other nationally important professions. In future, some certificate of competence from a national registration authority should be required before a man (or a woman) is allowed to farm on any but a quite small scale. This principle has already been officially adopted for smallholders.

The most serious question in British agriculture to-day is how to introduce more rapidly into practice on the majority of farms the new knowledge that agricultural science has made available. Research is needed on the limiting factors which prevent the established results of agricultural research being sufficiently widely and effectively applied. The greater the extent to which, during the very near future, these recent findings of science can be applied to the general improvement of farming quality, the less hard will it go with the nation when the highly artificial and somewhat inglorious receipt of aid from abroad comes to an end.

ENERGY IN THE SERVICE OF MAN

EXHIBITION AT BIRMINGHAM

IN connexion with the annual meeting of the British Association an exhibition has been arranged at the University of Birmingham to illustrate the topic "Energy in the Service of Man" suggested by Unesco for world-wide discussion and study in 1950. The exhibition has been sponsored by the National Coal Board, the Gas Council and the British Electricity Authority in conjunction with the Birmingham City Museum and Art Gallery and the Birmingham Common Good Trust, and is staged in the Mechanical Engineering Department of the University at Edgbaston. It was open to the public during August 21–29 and will be open again during September 7–9 after members of the British Association have had the opportunity of visiting it during the period of the meeting.

It is fitting that such an exhibition should be held in Birmingham, which owes its rapid development to the early exploitation of industrial power following the inventions of that small group of men who made the industrial revolution possible. The first section of the exhibition pays tribute to the work of these inventors, many of whom had close connexions with Birmingham; drawings, letters and memoranda from the Boulton and Watt collection are on display, with William Murdock's note-book and a calculation book of James Watt, alongside working models of early steam engines. The original engine constructed by Murdock in 1784 and the first electroplating machine patented in 1842 by John Stephen Woolrich, a Birmingham chemist, are notable exhibits.

Coal is the main source of energy in Great Britain, and the formation of a coalfield from forest debris is illustrated in a series of coloured plates showing various stages in the process. A selection of fossil remains of Coal Measure plants accompanies this exhibit.

The development of mining methods during the past two hundred and fifty years is shown by a series of diagrams and models. The horse whim and various types of gin used for raising coal before the invention of steam engines contrast markedly with modern examples of mechanization, and the hazardous nature of early mining operations is exemplified by a model demonstrating a method of setting off underground gas accumulations by the use of a naked flame. Sectional models illustrate the principles of 'room and pillar' and of 'longwall' methods of mining, and new developments in coal cutting are represented by working models of the hydraulically operated Samson stripper, which shears off the coal face and ploughs it on to a conveyor as it advances, and by the Meco-Moore cutter loader. A full-scale modern coal cutter is shown working along a portion of a longwall face.

Coal coming from the pit contains shale and other impurities, and as thinner and deeper seams are mined, and as mechanization increases, so does the amount of dirt. Coal cleaning thus becomes of great importance, and the principles of a dense-medium coal-washing plant are indicated by a model in which the coal is shown floating in a medium of specific gravity greater than that of coal but less than that of the dirt, which sinks and is removed.

Coal utilization is excellently portrayed, and a number of diagrams show the numerous by-products of coal carbonization. Sectional diagrams of a typical combination underjet coke oven and of a modern continuous vertical-retort setting indicate the principal methods of high-temperature carbonization employed at the present time; flow diagrams and a working model of a gasworks provide further information. The extraction of benzole from coal gas as practised in the gas industry is described by an attractive flow diagram, and the cycle of operations of an automatic carburetted water-gas plant is realistically reproduced by another model.

The downjet-combustion of coke is described and methods of testing this solid fuel are shown.

Refractory materials are widely employed in the gas industry, and a series of well-chosen exhibits show methods of testing these materials and their deterioration in use.

The removal of tar fog from coal-gas by electro-detarrers is now a common procedure at gasworks. This process resulted directly from the work of Sir Oliver Lodge (the first principal of the University of Birmingham) and of Dr. F. G. Cottrell in the United States, and an effective demonstration of electrical precipitation is included in the exhibition.

A series of photographs illustrates recent investigations by the Gas Research Board and the use of modern scientific instruments in the gas industry.

Waste-heat recovery is a topic of considerable interest to the gas engineer, for the flue gases leave retort settings at about 900° C., and by passing these through waste-heat boilers a considerable saving in fuel can be effected. As an alternative procedure, a 700-kW. closed-cycle gas turbine is to be installed at a West Midlands gas works; a model of this unit is displayed at the exhibition.

A selection of modern gas burners and an illustration of gas distribution methods complete the gas section.

The British Electricity Authority is at present building thirty-eight new power stations and installing new plant at forty-three existing ones. The generation of electric power and new developments are illustrated at the exhibition by a number of well-chosen models and demonstrations, including sectional models of the generating station at Staythorpe and of a typical hydrogen-cooled turbo-alternator. A particularly interesting exhibit is a model of the Metropolitan-Vickers 15,000-kW. gas turbo-alternator designed for the Trafford Park station of the British Electricity Authority.

Water cooling presents a considerable problem at power stations, and working models of cooling towers are on view.

The recovery of a valuable element from a waste product is depicted in this section of the exhibition. It has been known for a number of years that the flue-dusts from boilers and gas producers contain small amounts of germanium, gallium and other rare elements, and it has been found that certain coals from the Northumberland and Durham coalfield yield up to 0·001 per cent of germanium. The extraction of this element is now undertaken commercially from flue-dust because of its valuable properties as a semi-conductor. Germanium diodes and triodes are displayed alongside samples from various stages in the extraction of the element.

A novel exhibit is the fuel cell constructed by the British Coal Utilization Research Association. The prospect of developing electrical energy directly has for long attracted the attention of investigators, but no fuel cell has yet proved completely successful.

Demonstrations of electrolytic polishing and of tests on a television receiver lend interest to this section, and further exhibits deal with the transmission of electric power and its use in the electric arc furnace employed in alloy steel manufacture.

The visitor leaving the exhibition is faced by a small pellet of uranium with an accompanying notice which reminds him that quick results should not be expected from work now in progress directed towards the use of atomic energy for power production. Design studies and cost estimates for nuclear reactors will necessarily take a number of years to complete, before plans for full-scale nuclear power producers can be made.

In connexion with the exhibition, five public lectures have been delivered at the Midland Institute, Birmingham, by Mr. W. V. C. Gale, Mr. James R. Beard, Dr. A. Parker and Prof. F. H. Garner, and on September 5 Sir Alfred Egerton will deliver a concluding lecture on "Civilization and the Use of Energy". Films are being shown daily while the exhibition is open.

The exhibition has been extremely well planned, and the exhibits are displayed effectively against a modern background which by its simplicity does nothing to distract the attention. The organisers are to be congratulated upon the arrangements adopted, and the exhibition deserves to be well attended.

A separate exhibition dealing with oil fuels is being shown to members of the Association in the University's Chemical Engineering Department.

NEWS and VIEWS

Civil Engineering at Birmingham : Prof. C. Batho

PROF. CYRIL BATHO, who retires in September, has occupied the chair of civil engineering in the University of Birmingham since 1924. Educated at the University of Liverpool, he later studied at Berlin and Charlottenburg and in 1908 was appointed lecturer in civil engineering, and in 1911 assistant professor, at McGill University. During 1912–13 he acted as design engineer on the New Quebec Bridge, and in the following years published a number of papers on the stresses in structural members and connexions. After a period at the Royal Aircraft Establishment during the First World War, he became for a short time a lecturer at Trinity College, Cambridge, and in 1919 was appointed associate professor of applied mechanics and hydraulics at McGill University, where he remained until 1924. Prof. Batho was chairman of the Midland Association of Civil Engineers during 1932–34. As a member of the Steel Structures Research Committee he was responsible for a series of important investigations, the results of which appeared in reports of the Committee published in 1931, 1934 and 1936. He served also on a committee of the Institution of Civil Engineers which reported in 1938 on concrete containers for the storage of liquids, and, for a number of years, was engaged in research on reinforced concrete structures, a subject on which he published several papers. Since the termination of the Second World War he has directed a series of investigations supported by the Aluminium Development Association and related to the design of large structures in light alloys. Although Prof. Batho's main interests were concerned with statically indeterminate structures and with riveted and other connexions, his work has covered a range of subjects, including creep in concrete and torsional stresses in thin-walled prisms. He has also wide interests in music, literature and the arts, which have led him on numerous journeys to Continental centres. His excellent lectures, illumined by a ready humour, will remain long in the memories of his students, and his colleagues will miss his wise and single-minded counsel in faculty and senate.

Dr. S. C. Redshaw

DR. S. C. REDSHAW, who has been appointed to succeed Prof. Batho, graduated at University College, Cardiff, in 1927 and took his Ph.D. in 1936. During 1927–32 he held posts in the aircraft industry. From 1933 until 1936 he was assistant lecturer in civil engineering at the City and Guilds College, Imperial College of Science and Technology, and acted as consultant to the British Aeroplane Co. In collaboration with Prof. A. J. S. Pippard he carried out research for Vickers (Aviation), Ltd., on geodetic construction. During 1936–40 he was scientific officer at the Building Research Station, where he specialized on research into the strength of bridges. In 1940 he was appointed chief airworthiness engineer and in 1945 chief engineer of Boulton Paul Aircraft, Ltd. In 1948 he became a director. As chief engineer he was responsible for all the technical work of the Company and for control of the design staff. His work has consisted of research and development in connexion with experimental methods of stress analysis, including model structural analysis, photoelastic and electrical analogue methods. The development of electronic methods of strain gauge measurements and the design of instruments for the automatic recording of strains and deflexions in flight also came under him. He is a member of the Mechanics Committee of the Aeronautical Research Council and of the Technical Board of the Society of British Aircraft Constructors. He is also president of the Birmingham branch of the Royal Aeronautical Society and vice-president of the Wolverhampton Engineering Society.

Botany at the British Museum (Natural History) : Dr. J. Ramsbottom, O.B.E.

AFTER almost forty years' service, the last twenty as keeper of botany, Dr. J. Ramsbottom will retire from the British Museum (Natural History) in October. In this key position he has had a profound and beneficent influence on British botany. On going to the Museum he specialized in fungi and soon became one of the foremost mycologists with a special interest in the larger fungi. During his keepership he became interested in a number of learned societies and more especially in the British Mycological Society, one of the friendliest groups of biologists that has ever existed, which owes much of its intimate character to his influence. Outside Great Britain he has done much to foster international understanding by his active friendship with mycologists all over the world. Dr. Ramsbottom has always insisted on the importance of broadly based taxonomy, and his own taxonomic interests have extended beyond the larger fungi to many groups of microfungi and especially to those of medical importance. With the sudden development of interest in antibiotics aroused during the Second World War by penicillin, his advice was of great importance, and he has rightly insisted that mycologists and not chemists are the proper people to be entrusted with the growth of moulds. His influence in mycological education has been great. By means of lectures and displays arranged in autumn at the Museum, he has aroused widespread interest in fungi and has been responsible for introducing many a student to mycology. He has made varied and valuable contributions to mycological literature. Nearly every naturalist who forays among the fungi has a well-worn copy of his "Handbook of the Larger Fungi"; his little book "Fungi" (published for sixpence by Benn in 1929) is one of the best introductions to mycology in existence; his presidential address to the Linnaean Society, "The Expanding Knowledge of Mycology since Linnæus", is a major contribution to the history of botany; and his two little King Penguin books, "Edible Fungi" and "Poisonous Fungi", have extended interest in these organisms throughout the length and breadth of Britain. On leaving the Museum, Dr. Ramsbottom by no means retires from mycology. Indeed, he remains one of the most active figures in British botany. His many friends the world over will wish him a long and happy retirement.

Dr. George Taylor

DR. GEORGE TAYLOR has been appointed to succeed Dr. Ramsbottom. Dr. Taylor was born at Edinburgh on February 15, 1904, and was educated at George Heriot School, proceeding thence to the University of Edinburgh, where he had a successful academic career. Immediately after taking his degree he accompanied the late Reginald Cory and others on a horticultural collecting trip to South Africa. He entered the Department of Botany of the British Museum (Natural History) in 1928. His work was principally concerned with Gamopetalæ; but he continued with his monograph on the genus *Meconopsis*, which was published in book form in 1934. In 1934–35 he went as botanist to the British Museum Expedition to East Africa, and made extensive collections on Ruwenzori and other mountains of western Kenya. Another opportunity to study alpine flora came in 1938 when he was invited to accompany the well-known botanical collectors F. Ludlow and G. Sherriff on their expedition to Tibet. Most of the plants collected previously had been those likely to prove of horticultural interest, and, consequently, the fully representative sample of the flora which was obtained is extremely valuable. Unfortunately, before much could be done with it, war broke out and almost immediately Dr. Taylor was seconded to the Air Ministry with the rank of principal. He returned to the Museum in 1946 and was soon afterwards appointed deputy keeper. He is an active student of the British flora, particularly of the rarer plants of the mountains of Scotland. At another level he has worked at aquatic plants, chiefly Podostemaceæ, but also, in collaboration with J. E. Dandy, is monographing the British species of *Potamogeton*. Dr. Taylor is a keen gardener and has been active in the study of the horticultural possibilities of Himalayan plants. For many years he has been recorder of Section K (Botany) of the British Association.

Augusto Righi, For.Mem.R.S. (1850–1920)

A HUNDRED years ago, on August 27 at Bologna, Augusto Righi, the Italian physicist, renowned for his researches in electricity, magnetism and light, was born. Most of Righi's life was spent in Bologna and he was professor of physics in the University from 1889 until his death on June 8, 1920. His earliest work was on the change of the electrical resistance of bismuth in a magnetic field, and he applied this phenomenon to the measurement of magnetic fields. He also studied the Kerr effect and found the variation in the plane of polarization with the wave-length of light. About 1880 Righi began a long series of researches on electric discharge *in vacuo* and in air, and this, in various forms, remained his main interest for the rest of his life. He observed the photo-electric discharge from a zinc plate on exposure to ultra-violet radiation and investigated the trajectories of cathode rays in a magnetic field; though the discovery of the electron eluded him, he was aware of the existence of negative carriers of electricity. Righi's name has been associated with a special form of Hertzian oscillator which is similar to the apparatus for the transmission of radio waves first used by Marconi, who knew of Righi's work but was never, as is sometimes erroneously supposed, one of his pupils (see Marconi's tribute in *Nature*, 105, 526; 1920). Righi also wrote papers on the change of length due to magnetization, change of size in insulators under electric stress, and radioactivity. Of the many honours that were conferred upon him may be mentioned the 10,000-lire prize of the Academia dei Lincei and the Hughes Medal of the Royal Society. He was elected a foreign member of the Royal Society and of the Royal Academy of Sciences at Uppsala, and in 1905 was made a Senator of the Italian Parliament.

On the occasion of the centenary of the birth at Bologna of Augusto Righi, the Italian Physical Society is holding a congress there during September 15–20. A number of foreign physicists have been invited to participate. No specific programme has been prepared, and the various sessions of the congress will be arranged along the lines of the papers presented.

Royal Society of Canada: Annual Meeting

THE annual meeting of the Royal Society of Canada was held at the Royal Military College, Kingston, Ontario, during June 5–7. Among the new officers elected for the year 1950–51 were: *President*, Dr. J. J. O'Neill; *Honorary Secretary*, Dr. Seraphin Marion; *Honorary Executive Secretary*, Dr. W. H. Cook; *President, Section* 3, Dr. H. G. Thode; *President, Section* 4, Dr. P. S. Warren; *President, Section* 5, Dr. L. C. Simard. The Flavelle Medal was awarded to Dr. C. H. Best, the Lorne Pierce Medal to Dr. M. Barbeau, and the Tyrrell Medal to Dr. J. B. Brebner (Columbia University, New York). Twenty-two new Fellows were elected to the Society. During the course of the meeting various symposia were held, one under the auspices of the Society entitled "The Arctic", one under Section 3 on "The Atmosphere of the Stars and Planets", and a third, under Section 5, on "Biological Macromolecules". Dr. J. A. Pearce, the retiring president, addressed the Society on modern concepts of the universe. Dr. T. L. Tanton, retiring president of Section 4, discussed "The Origin of Iron Range Rocks", and Dr. T. W. M. Cameron, retiring president of Section 5, spoke on "Parasitology and Evolution". Dr. Cameron's paper considered evidence presented by certain groups of internal parasites on the evolution of their hosts and suggested, *inter alia*, a separate origin for the South American and Australian marsupials. It is also suggested in the paper that Africa and South America must have been joined in early Tertiary times, but that no connexion between those two continents and Australia need be postulated by the parasitological evidence.

German Paint Industry

In a recent B.I.O.S. Survey of "The Paint Industry in Germany during the period 1939–1945" (Report No. 22; H.M. Stationery Office, 1950; 3*s*.), the authors, Messrs. N. F. Fisk and H. W. Bowron, have collated and classified material relating to the paint industry from more than two hundred reports on German industry. Their survey is divided into four main divisions: (1) Paints, Varnishes and Printing Inks; (2) Waterpaints; (3) Cellulose Lacquers; and (4) Linoleum and Coated Fabrics. Among points brought out in the survey are the use of new pigments such as lead cyanamide, to which anti-corrosive properties were attributed, and chemically resistant silicon-containing pigments. As in other countries, much new work was done in Germany during the War in the field of synthetic resins such as acid-catalysed air-drying urea-aldehyde and phenol-aldehyde resins, the rapidly-hardening polyurethane combinations of diisocyanates with alkyd-type [illegible]ials, and the extensively used aqueous emulsion [illegible] of polyvinyl acetate and polyacrylates. [illegible]ne was one basis of the German chemical [illegible]stry, and in addition to being the source of the [illegible]yl compounds, it was the starting material for [illegible]hydrofurane, a useful solvent for polyvinyl [illegible] nother basic process was the Fischer–[illegible]nthesis of hydrocarbons from carbon m[illegible] and hydrogen. This also served the paint indu[illegible] because it provided a valuable supply of fatty [illegible]ids and alcohols suitable for making plasticizing esters, and a fatty acid residue which was utilized in oil paints and waterpaints.

Blood-clotting and Allied Problems

The proceedings of the second Conference on Blood-Clotting and Allied Problems, held by the Josiah Macy Jr. Foundation in New York in January 1949, have now been published in a single volume (pp. 231; Josiah Macy Jr. Foundation, 565 Park Avenue, New York; 2.25 dollars). It contains articles on the separation and assay of a lipid antithromboplastin from human brain, blood, plasma and plasma fractions, on the chemical purification and mode of action of a thromboplastin inhibitor, on the standardization of thromboplastin, the structure of the fibrin clot and the mechanism of its formation, the surface effects on blood coagulation, zeta-potential studies, factors which influence the rate of conversion of prothrombin to thrombin, the blood platelets and coagulation and on a new synthetic anticoagulant (paritol). The discussions of these papers are also reported. An appendix describes the preparation and use of coloured and black-background lantern slides.

Christ's Hospital Science Journal and N.H.S. Report

It is with interest that we note the growing concern for science in schools, especially natural history, as evidenced by the increasing number of school science journals. Most of these, so far, are published by our public schools, the latest addition being the *Christ's Hospital Science Journal and N.H.S. Report*, the first number of which has recently appeared (No. 1, June 1950). The *Journal* contains several interesting articles, mainly by boys of the School. We note with regret, however, that only the ornithological section of the School Natural History Society has anything to report; this in a school so admirably situated for field studies is to be deplored. The *Journal* is to be welcomed, therefore, especially since its appearance might well not only record but also stimulate scientific field activities in the School. Copies of the *Journal* can be obtained from the Science School, Christ's Hospital, Horsham, Sussex, price 1*s*. 7*d*. including postage.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: S. D. Ross (assistant director of agriculture, Nigeria), director of agriculture, Gold Coast; W. E. Calton (government chemist, Zanzibar), government chemist, Tanganyika; A. Cawley (mining geologist, Nigeria), assistant director of geological surveys, Nigeria; D. W. MacGregor (veterinary officer, Nigeria), senior veterinary officer, Nigeria; L. P. Georghiades (statistical clerk, Medical and Health Department, Cyprus), statistics officer, Treasury, Cyprus; A. H. Millard (pharmaceutical chemist, Federation of Malaya), chief pharmaceutical chemist, Federation of Malaya; G. H. Swynnerton (senior game ranger, Tanganyika), game warden, Tanganyika; D. E. M. Marsh, assistant conservator of forests, Gold Coast; J. W. Cowie, geologist, Kenya; R. J. M. Gillies, veterinary officer, Northern Rhodesia; K. Nixon and A. G. Willder, veterinary officers, Nigeria; L. A. White farm manager, Department of Agriculture, British Guiana.

Announcements

The fourth Arthur Stanley Eddington Memorial Lecture will be given in London on November 2 by Prof. R. A. Fisher, Arthur Balfour professor of genetics in the University of Cambridge; he will speak on "Creative Aspects of Natural Law".

Mr. Reginald D. Meadows, demonstrator and supervisor in the School of Geography, University of Cambridge, has been appointed a lecturer in the Department of Education of the International Wool Secretariat. Mr. Meadows has specialized in the economic history of the woollen and worsted industries, and has travelled extensively abroad, where he had the opportunity of studying native sheep in North Africa, Malta, the Azores and Iceland. In Britain he has carried out a detailed survey of the early cloth industry of East Anglia.

A symposium on "Polymer Chemistry as Applied to Plastics" has been arranged by the Plastics and Polymer Group of the Society of Chemical Industry and will take place at Beveridge Hall, Senate House, University of London, during September 21–23. Details of the programme of papers have been published in the August 4 issue of *Chemistry and Industry*. Non-members of the Society may participate in the symposium. Further particulars may be obtained from the Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

SOCIAL AND SAMPLE SURVEYS FOR PLANNING AND ECONOMIC POLICIES

POLITICAL and Economic Planning is at present engaged on a major study into the whole field of the relations between government and industry, and the means by which the government gets its policy carried out. From this point of view of the ways of translating planning into practice, a recent broadsheet (No. 310) discussed the approach to planning and planning techniques so far as they are indicated in three recent books: Prof. W. Arthur Lewis's "Principles of Economic Planning"; Dr. T. Balogh's "The Dollar Crisis, Causes and Cure"; and the United Nations experts' report on "National and International Measures for Full Employment". The three books between them cover the greater part of the possible methods of translating planning principles into practice and indicate the current state of thought on the relation between the theory and practice of planning.

The first two were prepared for the Fabian Society; but whereas Dr. Balogh argues for selective controls which permit incentive to be given to progressive and efficient managements, Prof. Lewis regards planning through the market as the more flexible method. Only Prof. Lewis deals with the important point of mobility of reserves and labour in a full-employment policy, and his contribution is not sufficiently precise to be useful. All three books insist that the economy of a country cannot be planned in isolation from the rest of the world. The broadsheet, however, gives a comparative rather than a positive appraisal of the three approaches, reserving judgment until the factor involved in the psychological problem as well as that of organisation can be more accurately assessed.

Meanwhile, two further broadsheets dealing with one particular technique—the sample survey—have appeared (Nos. 313 and 314). The first of these examines the techniques used in such surveys to obtain facts about human activities and describes the recent work of the Government Social Survey and the use of sample surveys in market research. It emphasizes that the technique of sample surveys is not one for amateurs or untrained persons, and at present not all those who conduct sample surveys have the necessary knowledge and skill. The appropriate techniques vary widely, like the needs of users of sample surveys; and the limitations of the present methods can only be fully appreciated if the particular needs are considered separately.

In general, users must consider such questions as what degree of accuracy is required; whether detailed information and a correspondingly detailed interview are wanted; the extent to which informants are likely to be interested in the purpose of the interview, and the level of public co-operation needed to ensure successful interviews; the form of the question, record or observation that is appropriate to the problem in hand. When these questions have been answered, it can be decided what degree of skill will be required in the investigator, and whether a solution of the problem will involve detailed analysis and a high level of statistical competence in handling the results obtained. That is to say, what issues from a survey depends upon what is put into it; and, if the technique of sample surveys is not to be discredited, it is important, as the broadsheet rightly urges, that there should be a wider public understanding of the technical requirements for efficient surveys.

On the Government Social Survey, Political and Economic Planning concludes that this has proved an administrative tool of permanent value which provides a reliable and economical means of collecting facts needed both for policy-making and for assessing the effects of changes in policy on sections of the population. Nevertheless, it is doubtful whether government work benefits as much as it might from the existence of the Social Survey. In many branches of government activity decisions are either being made without previous assessment of the social facts, or withheld or delayed because it is believed erroneously that such facts are impossible to get. Decisions of the Ministry of Food are cited to illustrate this point, and it is also suggested that the nationalized industries should utilize the Social Survey.

The second broadsheet continues the review by discussing the use, and the criticisms of, public-opinion polls; the problems of readership surveys; how the British Broadcasting Corporation discovers the sizes and preferences of its audiences; and the uses of sample surveys in making special studies, particularly in the medical sphere, without the aid of permanent survey staffs. For success such surveys depend on the use of the services of workers skilled in other fields, and they are chiefly of value in enabling a wide field to be surveyed and profitable lines of inquiry to be determined for closer stud[illegible] The broadsheet is careful not to exagger[illegible] importance of sampling methods and points [illegible] too much importance can be attached to them. [illegible] surveys may yield results directly useful in dete[illegible]ining policy; others may only indicate the ne[illegible] for wide or more detailed research. The sample survey is no more than a rapid way of getting at the salient facts of a situation, and its advantage lies in the fact that it makes judgment freer by enabling it to concentrate immediately on the important issues.

Within these limits, Political and Economic Planning holds that the techniques of sample surveys are by no means fully developed, nor are the possibilities of present methods fully exploited. It is important that a professional spirit should develop among practitioners, and here the Market Research Society and the European Society for Opinion Surveys and Market Research could help. It is also suggested that the Government might provide the Social Survey with facilities enabling it to carry out the functions of a research organisation in the field of sample surveys. Survey reports also should be more widely available, and the possibilities offered by sampling methods should be made better known within the Civil Service. Warning is given against the use of departmental machinery when objective social results are needed. It is also suggested that a wider use of market research in industry at home might do much towards reducing costs, and that in overseas marketing full use of the facilities offered by the British Export Trade Research Organisation and like bodies would help to eliminate the 'hit and miss' methods which are all too characteristic of Britain's present overseas trading. Intelligently conducted public-opinion surveys could also show one half of the world what the other half thinks—and why—and could thus add something of real value to the general discussion of social and political issues which is a part of democratic organisation.

EDUCATION IN INDUSTRY

IN a paper presented to the summer meeting of the Association of Technical Institutions at Scarborough in June, Mr. T. H. Hawkins dealt with the industrial problems which had arisen out of part-time day release classes for young workers in industry. Part-time day release, he said, had been tried in practice and proved by experience and there was now no need to argue the cause for its necessity. Sufficient experience had been gained so that an assessment could be made from which the policy for future development could be elaborated.

Apart from the considerable difficulties of the administration of part-time day release classes, three main types of human difficulties arose. The first was from the point of view of young employees, many of whom cannot see why they should be forced, even for one day a week, to return to a place from which they had recently so mercifully escaped; some youths even prefer to stay at their jobs without pay to attending day release classes with pay. Since these adolescents are often the ones most requiring some supervision at a difficult time in their lives, Mr. Hawkins suggested that all classes should be of a compulsory nature.

From the management side the supposed antagonism of many industrialists towards part-time day release is often because they cannot see the link between general education and the young person's job in industry. They are ready to provide facilities for young people in their charge to attend classes of a technical nature; but cannot see what English or current affairs has to do with making boys or girls into better workers. Now that day release classes have been going some years, however, it is interesting that many managers have changed their minds about the value of these classes after seeing the beneficial effect they have on young people. Headmasters and teachers in part-time day release classes could do much to help departmental managers to see that part-time day release classes do connect with jobs by using many more illustrations than they do from local industries. In this connexion teachers could help themselves by being prepared to spend some of their vacations on training courses in different works.

From the industrial side the person who has most to do with the arrangement of part-time day release classes is the industrial education officer, and the particular difficulties which he sees are the way in which subjects are tackled in general education classes and the lack of suitable courses of a vocational nature for apprentice grades. In general education classes the more intelligent young people are dealt with quite adequately, although there is room for considerable experiment on how to deal with young people who are attending classes on one day a week only. With the less intelligent students, many of whom will have come from the lower classes of the secondary modern schools and may be near-illiterate, it is probable that subjects as such should be discontinued. The day release class teachers should work to an overall plan, but should be prepared to modify their daily programme according to the particular interest of the moment.

The industrial education officer is also concerned with the lack of suitable courses for apprentice craftsmen. Hitherto the emphasis in our technical institutions has been too much on providing suitable courses for the technician and not nearly enough on providing suitable courses for the craftsman. Recent suggestions for the upgrading of certain technical colleges and the launching of a Royal Institute of Technology may cause the craftsman to be even more overlooked and, as Mr. Hawkins pointed out, it should be always remembered that for every graduate in a works, there are about ten men for maintenance work of a routine character. Despite the comprehensive programmes prepared by the City and Guilds of London Institute, there are still no suitable courses for apprentice maintenance fitters, blacksmiths, pipe-fitters and other important maintenance crafts. The industrial education officer is also concerned because commercial apprentices cannot be deferred from National Service at the age of eighteen like other apprentices; on this point the Ministry of Labour and National Service shows a marked inability to adapt itself to changing needs and even to act in conformity with public utterances of Ministers like the President of the Board of Trade, who is continually stressing the need for an expansion of commercial staffs in industry. Mr. Hawkins also dealt with the difficulties caused by interference with production and the fact that the 1944 Education Act makes no reference to the question of who should pay the wages of students taking day release classes, as well as difficulties peculiar to certain industries.

CRYSTALLOGRAPHY IN SPAIN

THE official recognition in 1947 of the International Union of Crystallography was followed by the formation of national committees in a number of countries. The Consejo Superior de Investigaciones Cientificas appointed a Spanish National Committee in 1949, and announced its adherence to the International Union. This demonstrated to Spanish crystallographers the urgent necessity for the strengthening of contacts between the various laboratories and individual research workers within Spain itself. They decided, therefore, to form a Spanish Crystallographic Association, to include pure crystallographers and also chemists, physicists, engineers and others working with X-ray or electron diffraction methods.

The first meeting of the Asociacion Española de Cristalografia was held in Barcelona this summer during July 5–8. During the conference the following committee was appointed to hold office for the next two years: *President,* Prof. F. Pardillo; *Vice-President,* Dr. L. Rivoir; *Treasurer,* Prof. G. Martin Cardoso; *Secretary,* M. Abbad; and *Ordinary Member,* Dr. J. L. Amoros.

The proceedings included visits to the Crystallographic Laboratory in the University of Barcelona, and to the Museum of Mineralogy and Geology, established in the fine buildings originally used for a national exhibition. There was an excursion to the Montserrat range; this was only an interlude, however, in the more serious business of the day, which was a visit to the salt mine at Cardona, now worked mainly for potassium chloride. The scientific proceedings included two evening lectures given in English by Prof. K. Lonsdale, who had been invited to attend from Great Britain by the Consejo Superior de Investigaciones Cientificas and by the Association. These were on "Neutron Diffraction" and on "Thermal

Movements in Crystals", and were followed by considerable discussion. An afternoon lecture was given by Dr. Rivoir, on "Photometric Measurements in X-ray Analysis". He emphasized the importance of high-resolution photometric methods for the measurement of low contrast on photographic films and described work done in this connexion in the Instituto Alonso de Santa Crux, Madrid. Twenty-one papers were presented to the conference, but owing to limitation of time not all of these were read. The conference closed with a formal luncheon at the University.

The Crystallographic Laboratory in the University of Barcelona is well equipped both for classical crystallographical and optical measurements and for modern X-ray structural research, including the latest business-machine computational methods. Special mention should be made of the X-ray moving-film diffraction cameras designed by Dr. Amoros (for the equi-cone de Jong-Bowman and Weissenberg methods) which have been constructed in the Instituto Torres Quevedo (applied physics), Madrid. A compact slide-rule for structure-factor calculations designed and constructed by Dr. M. Font-Altaba was shown. This is able to multiply together the atom factor and an expression of the type

$$\binom{\sin}{\cos} 2\pi hx/a \binom{\sin}{\cos} 2\pi ky/b \binom{\sin}{\cos} 2\pi lz/c,$$

and to achieve an accuracy of more than 99 per cent. At the suggestion of Mr. Abbad, a circular slide-rule of a similar type is now being prepared.

Research work is now in progress in Spain, with financial support from the Consejo Superior de Investigaciones Cientificas, on many theoretical and practical problems, although there is not, at present, much technological application of X-ray crystallographical methods in industry. The emphasis is rather on pure research. At the conference, J. Garrido described a new way of interpreting Patterson syntheses which he called the "method of differences". This led to a discussion on the use and limitation of the Patterson method. In a paper by M. Abbad, Sta V. Gomis and S. Garcia on the crystal structure of $BaS_2O_6.2H_2O$, emphasis was placed on the fact that 'pseudo-extinctions' could be used to determine the heavy-atom co-ordinates more simply than by the Patterson projection which confirmed the results.

J. Amoros gave an account of some of the techniques he had seen used during a recent visit to Great Britain, and he also described the progress of his own researches on the structure of *l*-glutamic acid hydrochloride, using a trial-and-error method based entirely on Fourier syntheses, on a comparison of Spanish asbestos and chrysotile with about a hundred specimens from other parts of the world (with F. Pardillo) and on the ionic refraction of alums and of the Tutton salts. He has found that the presence of small, highly charged ions causes a marked depression of the refractivity. M. Font-Altaba described the use of his structure-factor slide-rule and also reported progress in structure determinations for saccharine and its metal derivatives. J. M. Font has made crystallographic studies of cerusite from Vallirana (Barcelona) and X-ray analyses of bauxites from north-east Spain. L. Rivoir showed Laue photographs of bent aluminium crystals with a discontinuous band structure in the reflexions instead of a continuous asterism. This discontinuous asterism disappears completely on straightening the crystal. L. Rivoir and S. Martinez Carreras have also studied thallium perchlorate by the powder method and have shown it to be isomorphous with thallium perbromate and potassium perbromate, but not with potassium perchlorate. G. Martin Cardoso gave a paper on the crystallographic study of diaspore as an intergrowth on andalusite. He also outlined the intention of the Association, which will meet regularly twice a year, to publish in Spanish a crystallographic bibliography, in the preparation of which members were invited to co-operate.

J. L. AMOROS
K. LONSDALE

AFFINITY AND REACTIVITY OF ANGIOSPERMS TO *PHYTOPHTHORA INFESTANS*

By K. O. MÜLLER
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FORMER literature[1] has indicated that the *Phytophthora*-resistance of the '*W*' varieties, discovered by me in 1923, is controlled by a gene that is not present in the common European varieties. This resistance is caused by the increased reactivity or the 'hypersensitivity' of the host cells which have been penetrated by a parabiontic strain of the parasite[2,3]. The phenotypical effect of this gene is therefore chiefly characterized by the extreme rapidity with which the affected cells collapse. Recent investigations have shown that in those genotypes possessing the highest degree of resistance, this collapse is effected within 7–8 hr., using potato sprouts and at a temperature of 22° C. Furthermore, there is associated with this rapid cell collapse a more or less intensive infiltration of the cell walls and cytoplasm by phlobaphene-like compounds which give the invaded tissues the well-known brownish colouring[4]. Finally, using tubers, it was experimentally proved that the reaction is unspecific. The tissue loses, in the course of this reaction with a parabiontic strain, its capacity to act as host for eusymbiontic strains of this fungus and for other bacterial and fungal parasites of the potato tuber[5].

We also found significant differences in the speed of the cell-collapse reaction of the different tissues within a genotype. In both resistant and susceptible genotypes this reaction proceeds most quickly in the young sprouts of the tubers and in the leaves of the plants. The cells of the inner parenchyma of the stems were usually found to react much more slowly. The reaction of the cells of the flower petals and the parenchyma of the tubers is very often so slow that the final stage in the reaction is not always completed. (The last two of the five stages which we can distinguish in the complete course of the reaction[3,4] very often do not take place in the susceptible genotypes because the infected cells die before these stages are reached.) Rapid reaction in the tubers and a slow reaction in the sprouts or leaves has never been observed in our material. These differences of reaction by the various tissues correspond to their ability to act as host to the invading parasite. They can be so great that in some genotypes the leaves are resistant whereas the parenchyma of the tubers behaves as if susceptible.

The close correlation between the reaction-speed and the degree of resistance was confirmed when other members of sub-section *Hyperbasarthrum* of the genus *Solanum* were investigated comparatively. This investigation covered mainly various forms of *S. demissum* and their hybrids with European potato varieties.

Besides the gene which controls the blight resistance in the '*W*' varieties, other genes also exert an influence on the reactivity to the different *Phytophthora* strains. Lehmann[6] and Black[7,8] have shown that only the species *Solanum demissum* possesses more than two different genes which are involved in the inheritance of the resistance to the different *Phytophthora* strains. Furthermore, we know that there are probably no plasmogenic differences which interfere with the action of these genes. This was proved in 1941–44 by investigating comparatively reciprocal crosses between *Solanum demissum* and *Solanum tuberosum* (unpublished). But the graduated 'virulence-resistance' relationship in one direction does not fully explain the situation. This became obvious when about fifteen years ago Müller[9] and Rœder[10] found that the '*T*'-strain of the parasite, highly virulent on all parts of the tomato plant, was unable to infect the '*W*' varieties. The '*S*' strain of the fungus, however, which is extremely virulent on the '*W*' varieties, cannot develop on the tomato leaves. This indicates a 'multidirectional' biological specialization.

The behaviour of the host plants when tomato is attacked by the '*S*' strain and '*W*' varieties by the '*T*' strain is also characterized by a heightened reaction velocity in the defence-reaction. This reaction has been described as that produced by the '*A*' strain of the fungus on the '*W*' varieties. It seems to be identical with regard to its morphological characteristics to that of '*W*' varieties in contact with a common strain of *Phytophthora*.

If we attempt to explain the above-mentioned facts on the basis of the formal principles which have been developed in human pathology concerning the nature of reactive immunity, they would be difficult to understand. On one hand we find extensive differentiation of the species *Phytophthora infestans* into numerous biologically specialized sub-races. (Up to 1944 I had collected thirty-one strains of *Phytophthora infestans*, all of which are differentiated by their different behaviour against the leaves *and* tubers of my test assortment.) Moreover, this differentiation is associated with constitutional differences in the host. On the other hand, the host organism repels the parasite with an unspecific reaction, and this seems to follow the same course in all possible parabiontic host–parasite combinations. If we adopt the reasoning prevalent in human pathology, one would seem to exclude the other. For then we should be obliged to assume that every constitutionally different host type possesses a more or less specific antibody system. It has been experimentally shown, however, that this is not so.

On the basis of experimental results with the '*W*' varieties, I tried to find a way out of this dilemma[9]. I made the supposition that the conspicuous persistence of the fungus-affected host cell in the eusymbiontic host–parasite combinations is due to a temporary metabolic 'concordance' between the two partners (*Konkordanz Hypothese*). In this case the metabolism of the parasite fits in with that of the host-cell. But, if there is such concordance in too small a degree, then the physiological unity of the affected host-cell breaks down rapidly with the simultaneous appearance of the unspecific 'phytoalexin' or 'phytoalexins', that is, substances which are developed or activated in the host tissues and act as 'antibodies' or 'antibiotics'. These phytoalexins prevent the continued penetration of the parasite into the host tissue. With regard to the unspecific character of the phytoalexin, I argued that the *sensitivity of the host cell* was the principle which determined the specific behaviour of the host to the parasite.

The influence of environmental conditions on the immunological behaviour of the host tissues was another important feature which enabled us to complete our conception of the nature of blight

Table 1. REACTIVITY OF THE AFFECTED HOST CELLS AND THE BEHAVIOUR OF *Phytophthora infestans* ('COMMON' STRAIN) IN SOLANACEOUS AND NON-SOLANACEOUS SPECIES (Temp.: 17–23° C.)

Host	Leaves	Parenchymatous tissue of stem	Petals	Parenchymatous tissue of fruit	Tubers or roots or bulbs	Remarks
Sol. tuberosum	+ to ± III	± III	± III	± III	± III*	* Some varieties exhibit greater or lesser reactivity
Sol. hybr. ('*W*' varieties)	+ + I	+ + to ± I to III	÷	± II*	+ to ± I to III	* Only one variety tested
Sol. demissum (certain varieties)	+ + I	÷	÷	÷	+ II–III	
Sol. demissum × *Sol. tuberosum*	+ + I	+ + to ± I to III	÷	÷	+ + to ± I to III	Only resistant hybrids
Sol. capsicastrum	—	± II–III	+ + I	± III*	÷	* Young fruits: + + I
Sol. lycopersicum	+ + I to II	+ II–III	± III	± III	÷	
Petunia hybrida	± III*	± III	± III	÷	÷	* Wounded leaves
Datura stramonium	± III	± III	± III	± III	÷	
Lycium halimifolium	± III	÷	÷	÷	÷	Leaves from seedlings
Cucumis sativus	—	—	÷	+ + II	—	
Lactuca sativa	+ + I*	—	÷	÷	÷	* Leaves from seedlings
Dahlia var.	+ + I*	÷	÷	÷	+ + I	* ,, ,, ,,
Phaseolus multiflorus	+ + I*	+ + II	± III	+ + II	÷	* ,, ,, ,,
Beta vulgaris	—	+ I	÷	÷	+ I	
*Brassica oleracea**	+ + I**	+ I	± III	÷	÷	* Var. *Capitata et botrytis* ** Young leaves
Anemone japonica	—	—	+ + I	÷	÷	
Allium cepa	—	÷	÷	÷	± III*	* Only occasional infection was observed

+ + : The first change of the host-cells (collapsing or developing the dark pigment) was observed 18 hours or less after the application of *Phytophthora* zoospores to the tissue.
+ : The first change was observed within 48 hours but after the lapse of more than 18 hours.
± : The first change was observed later than 48 hours after incubation.
— : No reaction.
÷ : Not tested.

I : The parasite is unable to progress from the point of infection; sporulation does not take place.
II : The parasite can only spread a little beyond the focus of infection; fructification absent or only a weak one.
III : The parasite spreads without restraint and fructifies luxuriously.
II–III : Behaviour of the parasite not constant; fluctuating between III and II.

resistance. Temperature and narcotics can so alter the reactivity of the host plant that susceptible genotypes exhibit the behaviour of resistant ones, and *vice versa*[11,12]. This led us to the opinion that, *potentially*, the susceptible genotypes were also capable of defence reaction. The low reaction-speed in the eusymbiontic host–parasite combinations did not permit the defence necrosis to develop with sufficient rapidity to prevent continued penetration by the parasite. But if this is so, then the gene or genes which control the reactivity to the different strains of *Phytophthora* would be similar in action to the realizators (genes that determine which of two alternatives will be realized) in sex-determination of diœcious plants having separate sexual forms. We may therefore postulate a functional system corresponding to Correns's *A–G–Z* complex. Thus the possession of this functional system would be a necessary primary condition if the host plant is to react in any way against the parasite.

Even if we cannot draw a complete analogy between sexual determination and immunological behaviour (a fundamental difference exists in so far as the reaction norm of the potato, attacked by blight, depends not only on the genotype of the host, but also on the *modus operandi* of the parasite), the analogy seemed nevertheless sufficiently far-reaching so as to justify the experimental examination of the following working hypothesis: If the function of the 'resistance genes' is actually only that of determining when and with what velocity the unspecific defence necrosis occurs, then it is very probable that there is a basic functional system possessed not only by the potato and its allied species, but also by plants much further distant in the phylogenetic sense. Therefore, if the cells of the latter take up the blight fungus, we may expect that they will exhibit the same immunological behaviour as the '*W*' varieties or the resistant *Solanum tuberosum* × *S. demissum* hybrids. But if this is not so, we would have to postulate that in such cases a eusymbiontic host–parasite relationship is established, supposing that there is the right nutrient substrata for the parasite. Both would be according to the 'concordance hypothesis'.

The most important feature in carrying out these experimental investigations was to ensure that the parasite was brought into direct contact with the plasm of the host plant under examination. This was necessary because the absence of any reaction on the part of the host did not necessarily mean that there was no affinity between host plasm and parasite. For example, the mechanical structure of the individual cell walls would constitute a barrier to the parasite and prevent it from gaining any contact with the reactive plasm. Therefore, after inoculations, our observations under the microscope had to be continuous to enable us to determine whether any real biological contact was established between host and parasite.

Of the species which exhibited clear affinity to *Phytophthora infestans* listed in Table 1, nine do not belong to the Solanaceæ family. *After artificial inoculation with a common strain, they all showed reactions which were similar in all apparent characteristics to those observed in plants of the sub-section* Hyperbasarthrum *of the genus* Solanum. Like these, they exhibited varying degrees of 'sensitivity' to the blight fungus (measured according to reaction velocity), and many of them are phylogenetically far removed from the genus *Solanum*.

Even the monocotyledonous plant *Allium cepa* possesses tissues which not only can be infected by *Phytophthora*, but can also be used as a nutrient substrate sufficient to bring the fungus to fructification.

Table 1, however, also demonstrates another fact. There are distinct differences in the ability of the various organs of particular plants to serve as host for the parasite. The behaviour of *Phaseolus multiflorus* was studied in detail because the plasma constituents of this plant form an excellent nutrient substrate for *Phytophthora infestans*. All degrees of sensitivity were observed in this plant. The reaction of the inner skin which lines the cavities containing the bean seeds was particularly remarkable. Within sixteen hours of application of the *Phytophthora* zoospores (22° C.), a dark brown discoloration and a necrosis of the contacted host tissue appeared. This tissue reacted as sharply and as quickly to *Phytophthora* as sprouts from tubers of the '*W*' varieties (see accompanying illustration). The petals of *Phaseolus multiflorus*, however, reacted relatively slowly to the penetrating germ tubes of the *Phytophthora* zoospores. The weakness of the reaction in this case is accompanied by a surprisingly strong development of sporangiophores.

Using observations from Table 1, the material in Table 2 was produced to show the correlation between the reaction-speed of the host cells and the behaviour of the parasite. The correlation coefficient $+ 0\cdot7781 \pm 0\cdot0380$ is significant, so that in this heterogeneous collection of monocotyledous and dicotyledonous host plants we find the rule confirmed: The more rapid the necrotic reaction of the invaded cell, the greater is the resistance of the plant as a whole.

Our experiments also indicated another important feature. All unusual host plants used, such as *Phaseolus* and *Brassica*, behaved in the same manner irrespective of the *Phytophthora* strain inoculated, though these strains each exhibit a different behaviour on the '*W*' varieties, on *Solanum demissum* varieties and on *Solanum demissum* × *S. tuberosum* crosses.

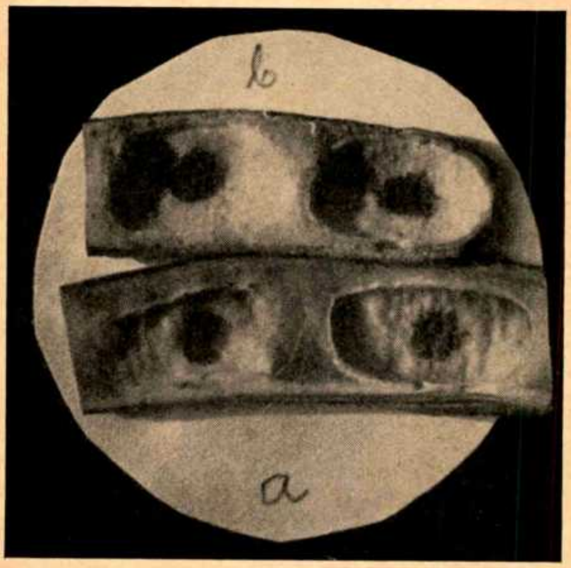

Photo: Hughes

Necrotic spots on the skin of the seed cavities of bean pods, caused by *Phytophthora infestans*. (Incubation time, 22 hours' temperature, 17·5–21° C.)

This fact supports the suggestion that the hypothetical antibody which is activated or developed in the dying *Brassica* cells, as in the '*W*' varieties, is not specific.

We did not, however, succeed in inducing a reaction between strains of *Phytophthora infestans* and all the host plants that were inoculated. For example, we were unable to induce any reaction between the inner parenchyma of adult stems of *Sambucus niger* or *Rudbeckia* sp. (var. *hortensis*) and *Phythophthora.* The question in these cases is whether any affinity exists between the plasm of the host tissue and the parasite, or whether because of mechanical difficulties real contact between living host cells and the parasite did not take place.

However, these negative results do not affect the conclusion that affinity and reactivity to *Phytophthora infestans* are characters which may be possessed by many of the division Angiospermæ regardless of the phylogenetic position of the plants concerned.

Table 2. Correlation between the reaction-rate of the host-cells and the behaviour of the parasite

		Behaviour of the parasite			
		I	II	II–III	III
Reactivity of the affected tissue	++	13	4		
	+	4	1	1	
	±		1	2	23

Even though these experimental results appear to support our theoretical interpretation of the nature of *Phytophthora* resistance, it is possible that the same phenomena may have different causes, and different ones may have the same cause. It would therefore be premature to consider it proved that the defence necrosis in *Phaseolus* or *Brassica*, for example, is identical in all respects with that observed in the '*W*' varieties. But all observations of the course of reaction which follows the invasion by the parasite into the living cell indicate that the part of the metabolic system first affected by the invading parasite must be very common in Angiosperms. From the physiological point of view the specific 'sensitivity' of this functional system, controlled by significant genes, is the decisive factor for the reactive behaviour of the plant.

There is no doubt that the system first affected by the parasite is an enzymatic one and there are certain reasons (phenomenon of specificity, sensitivity to narcotics, connexion with the respiration metabolism and appearance of phenolic substances in the course of the defence reaction) that the system in question is connected or even identical with the dehydrogenase-system. Biochemical research must make clear whether this last suggestion corresponds to the facts.

Because cells of the susceptible plants possess a higher degree of persistence in the presence of the parasite than the resistant ones, we must conclude that a 'normal' parasitic relationship can only be realized when the speed of collapse of this system does not exceed a certain limit. If this limit is exceeded, then the necrotic reaction of the host-cell follows so quickly that the advance of the parasite is halted. That is not to say, however, that the graduated sensitivity is the only constitutional factor which determines whether a plant can become diseased by *Phytophthora infestans* or not. I am quite aware that certain other factors are involved. These experiments have shown that some of them work in complete independence of the reactivity of the plant. For example, the old leaves of *Petunia* with a low reaction-speed or those of *Nicotiana* are protected from the invasion of *Phytophthora* by the particular structure of their epidermis. In other cases the development of the parasite is determined by the suitability of a particular plant as a nutrient substrate. In plants with an intermediate reaction velocity relatively small quantitative differences would suffice to shift the balance of the ratio 'reaction-speed of host cells : development capacity of parasite' in favour of the host or of the parasite. It may also be possible that there are unspecific cell constituents of simple structure that exert an inhibiting influence on the parasite and alter the ratio in favour of the host. Nevertheless, it is quite clear from the facts we have considered that establishment of a normal parasitic relationship is dependent on relative tolerance or 'hyposensitivity' of the host plasm to the influences which are exerted by the invading blight fungus.

Furthermore, we conclude that the reactive *Phytophthora* resistance (or *vice versa*, susceptibility) is not a quality in the narrow sense of the word, as petal colour or leaf shape, but rather is a functional character which becomes efficient only when direct contact has been established between host and parasite. Therefore, that which is significant for the 'hyposensitive' blight-resisters is really not a gene for blight-resistance itself, but rather genes controlling a reaction potential, probably possessed not only by the genus *Solanum* but also by many other species of the division Angiospermæ.

Finally, I would like to direct attention to the relative character of the expression 'hypersensitivity'. Our experiments have shown that the affinity to *Phytophthora infestans* is not restricted to the genus *Solanum*. Moreover, we found that the hypersensitivity reactions seem to be the rule if we expand our considerations to the whole division Angiospermæ. 'Hyposensitivity' then seems to be the exceptional quality and not 'hypersensitivity'. So that if the term 'hypersensitivity' is used in the common sense, it must be remembered that its use is justified only when it is restricted to considerations of the behaviour of the genus *Solanum*. But regarding the reactivity of the whole division to which solanaceous plants belong we had to change our point of view. The exceptional behaviour is then represented by extremely 'hyposensitive' forms which seem to occur with frequency only in *Solanums*. Consequently, we had to designate the hypersensitive plants as 'normosensitive' ones.

I wish to acknowledge the help received from my colleague, Mr. J. Munro, of the National Institute of Agricultural Botany, Cambridge, in carrying out this work. I am also indebted to Miss M. Kostrowicka for technical assistance.

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STRUCTURE OF WOOL FIBRES

Isolation of an α- and β-Protein in Wool

By Dr. P. ALEXANDER and C. EARLAND
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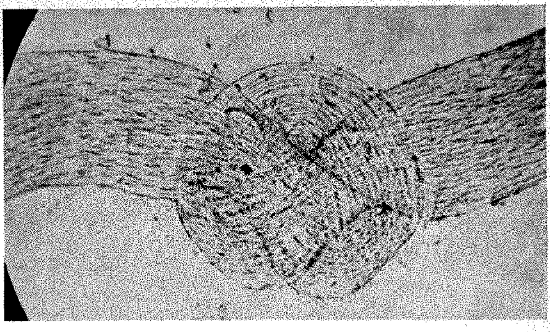
AQUEOUS solutions of peracetic acid oxidize the disulphide bond in wool to two sulphonic acid groups without attacking other major groups[1]. After more than 90 per cent of the cystine has been oxidized to cysteic acid, the wool becomes freely soluble in dilute alkali (for example, $N/10$ ammonia), except for a fraction representing 7–10 per cent of the total wool substance which remains insoluble[2]. Further treatment with peracetic acid has no influence on the solubility in alkali of this phase. The insoluble fraction is a continuous tubular membrane running the whole length of the fibre (see photograph); it is situated outside the cortical cells and forms part of the histologically highly complex cuticle of the wool[3], is readily filtered off, and on drying gives a pale yellow powder. 70 per cent of the protein which dissolved in ammonia was precipitated on acidification of the solution, and dried in a vacuum desiccator to give a white to pale yellow powder. This was freely soluble in dilute alkali giving highly viscous solutions which could be readily reprecipitated by the addition of further acid. The results given in the following communication show clearly that the insoluble phase has a β-keratin structure, while that of the soluble component has an X-ray diagram similar to that expected from a powder of α-keratin[4].



Insoluble β-membrane from a Lincoln wool fibre. ×80. (The fibre was knotted so as to demonstrate the continuity of the membrane)

Using a solution of bisulphite and urea, Mercer[5] claims to have extracted from wool a small percentage of a gum capable of being drawn into a fibre giving an α-photograph. This result has been discussed by Happey[6], who suggested these possible alternative explanations of the phenomenon: either that the α-protein molecules were present as aggregates and were never in solution as single chains, and in consequence retained their specific α-form, or that single molecules regenerated from solution were capable of crystallization in the α-form. In this present work, however, the question of molecular aggregation and the α-structure tends to resolve itself, since the protein can be precipitated in the α-configuration from extremely dilute solutions in which any aggregates of molecules present in the original fibre are almost certain to have been dispersed. The major part of the soluble protein described here is electrophoretically homogeneous and has a molecular weight of approximately 70,000.

The α-fraction, besides dissolving in alkali, is also soluble in solvents capable of breaking the hydrogen bond, such as concentrated formic acid, which was studied in closer detail. On dilution with water, the protein is precipitated from the formic acid solution and the powder thus obtained is in the α-configuration. When the concentrated formic acid was removed by distillation *in vacuo*, the resulting protein was found to be in the β-form. The protein, when in the β-form, dissolves only very slowly in dilute alkali and swells much less than in the α-form. This suggests that there is more extensive interchain hydrogen-bonding in the β- than in the α-configuration.

This work has established that it is possible to retain or regenerate the wool molecules in the α-form from a solution of wool which has been solubilized by the oxidation of the disulphide bond only. It is interesting to note that the α-fold is not dependent upon orientation of the molecules in a fibre, that a specific biosynthesis appears not to be essential to its formation, and that the α- to β-transformation can be carried out without degradation by purely chemical means.

After treatment with peracetic acid, during which the fibre contracts but does not dissolve, the bulk of the wool structure still remains in the α-form, as little change other than a loss of orientation was detected in the X-ray diagram of wool after this reaction[7]. It is likely, therefore, that the insoluble membrane is present in the original wool in the β-configuration. The only difficulty is that if it were present in such proportion (namely, 7–10 per cent) in a normal orientated crystalline form, then it should be capable of identification from an X-ray diagram of untreated wool. Microscopic investigations of the cuticle in whole fibres and of the membranes as isolated here show both to exhibit negligible birefringence, indicating an absence of orientation which was also observed by Woods[8] in the X-ray picture of isolated scales. The presence of the β-deflexion of 4·65 A. on the equator of the X-ray diagram may therefore be difficult to detect in wool because of disorientation or the presence of a mixed α- and β-structure in the cuticle. It is hoped to investigate this problem in detail at a later date. If this sheath of a tough β-keratin is present on the outside of the fibre, it may have some bearing on the action of anti-shrink processes. The abrasion resistance of decuticulated wool is also greatly decreased, and this would be readily explained if the tough β-keratin was removed during the process.

The morphological position of the membrane has yet to be determined unambiguously, but it appears to be situated[2] between the microscopically visible scales and the cortical cells. One would expect the elasticity of a β-cuticle to be less than that of an α-cortex, and this has been observed by Lehmann[9], who showed that the cuticle of a hair broke up after extensions exceeding 40 per cent. It is reasonable to ascribe the chemical resistance and insolubility of the membrane in part to the greater inter-chain hydrogen bonding possible in the β-configuration; but its insolubility in solvents capable of breaking hydrogen bonds, such as cupriethylenediamine or strong solutions of lithium bromide[2], which readily dissolve silk, suggests the presence of additional covalent cross-links which are not present in the fibre as a whole.

Preliminary analysis shows that the nitrogen content of the two fractions is the same as that of the original wool, but that the sulphur content of both is reduced from 3·6 to 1·4 per cent for the α- and 1·6 per cent for the β-fraction, and no disulphide sulphur can be detected. After the peracetic acid treatment all cysteic acid formed by oxidation of the cystine is present in the wool, but most of this is associated with the low molecular-weight fractions which are not precipitated on addition of acid to the ammonia solutions.

From the physical changes produced by substances capable of breaking hydrogen bonds, Alexander[7] concluded that the fibrils of wool are made up of micelles which are joined to one another by disulphide cross-links, but that the molecules within the micelle are held by secondary valency forces only. The separation of wool without peptide-bond breakdown into fractions of different molecular weight and cystine content adds further support to this model. The low molecular-weight fraction rich in cystine may act as a cement between the micelles made up of the high molecular-weight protein which has a low cystine content.

In conclusion, it can be said that there is every reason to believe that the wool fibre is polyphase in structure, being comprised of at least two different structural components, namely, an α- and a β-protein. The β-phase forming part of the cuticle of the wool fibre is a tough skin which, from its chemical inactivity, can be considered as a protective membrane which surrounds and contains the main bulk of the fibre, an α-protein which is more readily susceptible to attack.

We wish to thank the directors of Wolsey, Ltd., for permission to publish this communication. It was thought that an X ray investigation would be relevant, but the specialized apparatus was not available in this laboratory. An advance copy of the relevant chemical data[2] was sent to Dr. F. Happey, who has now reported on the structural aspects of the problem. [April 25.

Note added in proof. Since writing this paper we have found that the soluble α-phase is capable of regeneration as an orientated fibre and gives an X-ray diagram very similar to that of the parent native wool. A detailed description of these experiments will be published in the near future.

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Polycrystalline Structure of Wool

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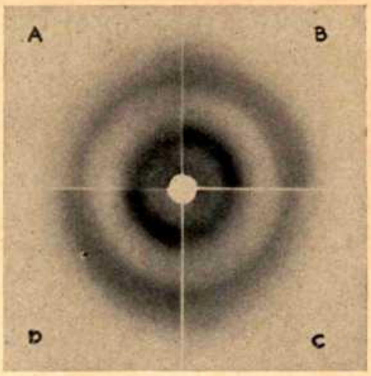
After treatment with peracetic acid, the protein of wool fibre can be divided into two fractions[1]: (*a*) the major portion of the fibre, which is soluble in weak alkali; and (*b*) a thin pellicle of protein which is continuous through the fibre in the form of a cylinder and which is insoluble in the above-mentioned alkali solvents. In all other respects, however, component (*b*) appears to have a chemical constitution similar to that of the bulk of the keratin fibre.

A precipitated sample of the soluble wool fraction and that of the insoluble protein pellicle are compared n the accompanying X-ray photograph and show very obvious differences of structure which can be summarized as follows: (*a*) the soluble keratin appears to be in the α-form, with a strong doublet of 10·5 A. and 9·5 A. and a ring at 5·2 A.; and (*b*) the insoluble fraction is in the β-form with a backbone spacing of 4·68 A. and a side-chain of 10·35 A.; as the X-ray diagram is obtained from a powder, it has not been possible to decide unequivocally at the present stage between a normal β- or 'cross-β-configuration', but it is felt that the former is the more probable.



X-ray photograph of wool fraction after treatment with aqueous peracetic acid. Quadrants *A* and *C*, powder from insoluble membrane showing β-structure after extraction of wool with weak alkali. Quadrants *B* and *D*, soluble fraction precipitated from solution in the weak alkali and showing an α-type structure. Copper $K\alpha$ radiation; $D = 4$ cm.

Based on the work of Bamford, Hanby and Happey[2], a study was made of the solution and precipitation of the soluble wool product from formic acid, and the following observations were made. (1) The keratin dissolved in formic acid and precipitated by water gave a normal α-type diagram, and its solubility in weak alkali was unchanged. (2) When the formic acid was removed *in vacuo*, the protein gave a β-type X-ray diagram; it was comparatively insoluble in weak alkali.

Three points of the greatest importance with respect to protein structure in general and that of the wool fibre in particular emerge from this work. First, it is clear that on breaking the cystine cross-links in wool, the main bulk of the fibre is soluble in weak alkali. In this case the alkali solubility is facilitated by the formation of sulphonic acid groups which gives the wool fibre a higher acidity than is normally found. The soluble fractions of wool obtained by the method of Dr. R. L. Wormell and me[3], in which the cystine cross-linkages are broken by sodium sulphide with the formation of —SH groups, do not appear so readily soluble in alkaline media. Secondly, the presence of a pellicle of β-keratin associated with the surface scales of the wool fibre tends to raise further doubts as to the advisability of considering the crystalline part of the wool fibre solely as an α-protein, since at least 5 per cent of the material is not α-protein after treatment with peracetic acid and extraction with weak alkali. It is reasonable to suppose also that the insoluble pellicle was β-protein before this treatment was applied. If this is so, then it is likely that the crystalline β-keratin skin of the cuticle of the wool tends to enhance the unreactive nature of the fibre. In this connexion, the insolubility and comparative intractability under normal conditions of the crystalline β-form of the polypeptides has been demonstrated by Bamford, Hanby and Happey[4] and is being reported elsewhere. It is sufficient at this stage to point out that, in the β-polypeptides, each amino-acid residue is associated with two inter-chain hydrogen bonds. Thus the presence of similar hydrogen bonds in the pellicle of the β-protein phase may well be one of the reasons for the unreactive nature of the wool fibre, especially if, in the bulk of the α-protein, the hydrogen-bonding is mainly intra-chain in character[5].

Thirdly, the behaviour of the protein molecule is very reminiscent of that of the copolymer of DL-β-phenylalanine plus glutamic γ-methyl ester. In this latter case[3], the solvent/polymer interaction appears to determine the form in which the molecule recrystallized from solution, that is, β from formic acid and α from metacresol. In the case of the soluble wool product, however, the α-form can be obtained by precipitation from formic acid with water; but as this protein is highly swollen in weak formic acid, this is not surprising. Where, however, the formic acid concentration is retained during precipitation, the protein is regenerated in the β-form.

In conclusion, it is of interest to note that in these experiments the soluble keratin molecules appear to crystallize on precipitation from solution in the α-form. This result seems to be in conformity with the work of Mercer[6] on the regeneration of wool from solution, but the description of his method of preparation of the soluble wool curd is not sufficiently detailed to allow of a more exhaustive comparison of the two results at this stage. Whether the folded form is due to the dispersion of aggregates of unchanged α-protein molecules being reprecipitated, or whether during precipitation from weakly alkaline solution the high acidity of the side chains favours the formation of intra-chain hydrogen bonds in single molecules, is clearly a matter of importance in the general theory of protein structure. From the work of Bamford *et al.*[4], however, on the structure of polypeptides, it is becoming increasingly obvious that the configuration of the α-fold may well be influenced by the environment of the protein molecule in solution, a possibility which I envisaged in an earlier publication[7]. Added to this there is the additional evidence of the α- and β-forms which can be prepared from formic acid solution. It is reasonable to suggest, therefore, in this case, that the solvent/protein interaction may influence the final structure of the molecule. Further work on these lines is being carried out and will be reported in due course.

I wish to thank the directors of Courtaulds, Ltd., for permission to publish this communication.

[April 25.

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MAUI THE DEMI-GOD

FROM time immemorial adventure stories have taken hold of the imagination, and this is partly why the cult of Maui-of-a-thousand-tricks is so widespread in the Pacific*. The origin of this hero is not unparalleled in other mythologies: born of human parents, he was brought up by the gods and learnt their magic, so that when he returned to earth he was able to use this knowledge in part to aid humanity, in part for his own diversion and pranks. After his return to his parents—to the great relief, it is said, of the gods, who were wearied by his precocious artfulness—he used his knowledge of magic to bring to earth all kinds of benefits hitherto enjoyed only by the gods: firm dry land, clear sky and cooling winds, daylight sufficient for cultivation and fishing and fire to cook with. For all these things he lives in the memory of the people; but he is not worshipped, for he was but man.

The cult of Maui, though predominantly Polynesian, is found also in Micronesia and Melanesia, principally where there has been contact with Polynesia. In some islands there is a long story cycle, in others merely a footprint, or the legend that he fished up the island from the deep. The legends naturally vary from island to island; there can be no 'true' account of this hero, but the fact remains that he won the hearts of the islanders over a vast region and maintained that hold for centuries. He was the hero of no particular class; the common men and women loved him, and even the priests had to recognize him as a wonder-worker. There are more biographies of Maui than he was reputed to have heads (the eight heads with which some legends credit him really symbolize his versatility).

Perhaps the best-known version of the Maui legend is that given by Sir George Grey, governor of New Zealand in the early 1880's, which is related in full in the Bulletin of the Bernice P. Bishop Museum under notice. Story-telling being such a feature of Polynesian life, it is not surprising that the Maui myth has increased and multiplied, fostered by the schools for priests or for those becoming specialists in literature in various islands. The myths also inspire experts in string figures who show in successive figures the sequence of Maui's hectic career. Here, one might mention that a string figure series was collected in 1914 from the Kiwi Papuans of the Fly River delta[1], representing Maui first as a young man and finally showing his two children, a pig and a dog (both introduced into the island by man). This figure illustrates a folk tale collected from the same source by Landtman[2], thus showing that the Maui myth has an even wider distribution than is indicated in the present work.

In plays and puppet shows, also, Maui appears, and he is a strong influence in poetry. The Maui myths vary considerably both in content and style, according to the locality and even to the character of the people relating them. In the Society Islands the myths have even become incorporated into the religious cosmogony, although in New Zealand they are almos universally regarded as non-sacred. Among th marginal islands, Melanesian influence is felt, with its preoccupation with monsters and good and ba heroes, the Maui myth being modified to cover thes predilections.

Katharine Luomala is to be congratulated on he perseverance in collecting this vast amount o material and for the diligence with which she has se her results on paper; the fact that the bibliograph runs into more than three hundred items speaks fo itself, and there is a full index.

K. RISHBETH

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* Bernice P. Bishop Museum. Bulletin 198: Maui-of-a-Thousand-Tricks, his Oceanic and European Biographies. By Katharine Luomala. Pp. vi+300. (Honolulu: Bernice P. Bishop Museum, 1949.)

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nuclear Shell Structure and Nuclear Density

THE existence of the shell structure of nuclei has been derived from a considerable variety of empirical facts (stability and abundance of nuclei, spin, magnetic moment, quadrupole moment, isomerism and β-decay)[1]. The closed shells of neutrons as well as of protons correspond to the numbers 2, 8, 20, 28, 50, 82, 126. Several theories[2] have been put forward, based on the model of a single nucleon moving in an average field of the rest. As it is not easy to conceive how a single particle embedded in matter of nuclear density could move in its own orbit without being disturbed by the others, we have searched for a more general explanation*. This is obtained with the help of a well-known relation first derived by Fermi, connecting the density $\rho(r)$ of a degenerate system of spin-half particles to the numbers of particles with angular momentum quantum number l. If one assumes that the formation of a closed shell is associated with the filling up of states of definite angular momentum, it follows that the closed shells are characterized by

$$[r^3\rho(r)]_{\max} = (2l+1)^3/24\pi^2.$$

Then calculations performed by the junior author show that the number of particles $N(l)$ in the l-th shell is

$$N(l) = f.(2l+3)^3,$$

where f is a quantity depending on the form of the density function $\rho(r)$. One sees that the difference of the cubic roots of successive shells $\Delta(N^{1/3})$ is a constant; namely, $2f^{1/3}$. Now this is at once empirically confirmed by the shell numbers in heavy nuclei, as shown in the following table:

$N(l)$	=	28	50	82	126
$\{N(l)\}^{1/3}$	=	3·04	3·69	4·35	5·01
$\Delta(N^{1/3})$	=		0·65	0·66	0·66

One can now calculate theoretically the shell umbers for different density distributions. The free Fermi-gas distribution gives too small a value of $\Delta(N^{1/3})$, equal to 0·52 instead of 0·66. However, a easonable density distribution $\rho(r)$, constant in the nterior and falling off like a Gaussian function near he border, namely,

$$\left.\begin{aligned}\rho(r) &= \rho_0 && \text{for } r \leqslant R_0\\ &= \rho_0 \exp\left\{-\left(\frac{r-R_0}{a}\right)^2\right\} && \text{for } r > R_0\end{aligned}\right\} \quad (1)$$

ives excellent result for $l \geqslant 3$. The constants ρ_0, and R_0, determined uniquely by the empirical elation $\Delta(N^{1/3}) = 0\cdot66$, are

$$\left.\begin{aligned}\rho_0 &= 1\cdot04\Big/\frac{4\pi}{3}r_0^3\ ,\\ a &= 0\cdot327\ r_0\ A^{1/3},\\ R_0 &= 0\cdot673\ r_0\ A^{1/3}.\end{aligned}\right\} \quad (2)$$

here r_0 is of the order of $1\cdot5 \times 10^{-13}$ cm.

The shell numbers $N(l)$ as calculated from (1) and) are tabulated in the following table:

l	=	3	4	5	6
$N(l)$	=	27·1	49·5	81·5	125·2
Next integer	=	28	50	82	126

For light nuclei, the central part of constant density no longer exists. When a purely Gaussian function is adopted for the nuclear density,

$$\rho(r) = \rho_0 \exp\left\{-\left(\frac{r}{a}\right)^2\right\}, \text{ with } \rho_0 = 0\cdot752\Big/\frac{4\pi}{3}r_1^3, \text{ and}$$

$$a = r_1\ A^{1/3},$$

where r_1 is also of the order of $1\cdot5 \times 10^{-13}$ cm.

We again obtain correctly the first three shell numbers:

l	=	0	1	2
$N(l)$	=	1·55	7·16	19·66
Next integer	=	2	8	20

There must exist, of course, an intermediate region, presumably between 20 and 28, in which the transition takes place. Theoretical calculation of the nuclear density according to Dirac and Jensen's refinement of the Thomas–Fermi model of nuclei is now in preparation.

Thus the shell structure, owing to its correlation with the nuclear density, throws light on the possible form of the latter. In particular, it turns out that the thickness of the surface layer, instead of being constant and of the order of the nuclear-force range, has to be proportional to $A^{1/3}$. We further infer that the existence of a central part of almost constant density is due to the effect of the Coulomb repulsion, without which the nuclear density would be nearly Gaussian for all nuclei.

Detailed calculation will be published elsewhere by the junior author.

* *Note added in proof.* After having finished this paper, we found that the problem has been tackled in a similar way by Iwanenko and Polyjew[3], but with less success; the reason being that only ordinary forces of the Yukawa type are taken into account while actually exchange forces are predominant.

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May 18.

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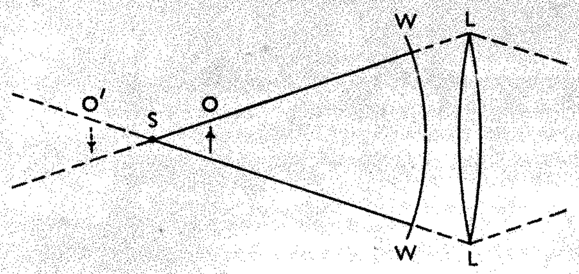
Microscopy by Reconstructed Wave-fronts

THE principle of Dr. D. Gabor's interesting method of reconstructing images of objects from photographs of the interference patterns produced when the object is illuminated with a coherent monochromatic wave-train is fully explained in his paper[1]. The treatment in this note is essentially the same, but I have ventured to present it in a very simplified form because I have found in discussions that difficulty is sometimes experienced in forming a physical picture of the reconstruction of the image, when the photographic plate can only record intensities of light and not phases.

The object O is placed close to a point source of light S. The wavelets scattered by the object interfere with the main waves from S over a surface such



as *WW*, altering both their amplitude and their phase. It is an essential condition for the success of the method that the amplitude due to the scattered waves should be small compared to that of the main waves. A photographic plate, which for simplicity we may suppose to coincide with a main wave surface such as *WW*, records the intensity of the resultant light at each point. The photograph is developed and printed as a diapositive. The pattern is quite unlike the object, being nearer to its Fraunhofer diffraction pattern than to a 'shadow'. Gabor then shows that if the diapositive is placed at *WW*, and the light is reversed, for example, by a lens *LL* focusing a beam at *S*, an image of *O* is reconstructed free from diffraction effects within, of course, the usual limits imposed by aperture and wave-length. Alternatively, the source *S* may be retained, and an eyepiece focused through the diapositive, when the image will be seen at the position of *O*. This result appears paradoxical because the photographic plate has only recorded intensities, whereas the formation of the image would seem to require that both amplitude and phase should be correctly reproduced.

The reason for the success of the method, and at the same time its limitations, can at once be seen if we picture wavelets scattered simultaneously by *O* and a corresponding object *O′* related to *O* by a centre of symmetry at *S*. The resultant of the wavelets from corresponding points at *O* and *O′* will have, by symmetry, a phase of 0 or π in relation to the main wave over the surface *WW*. Since this latter has a much larger amplitude, the total resultant phase is the same over *WW* and the only variation is in amplitude; complete information about this variation is recorded by the photographic plate.

When, therefore, the light is reversed through the diapositive, its wave form is that which would have been produced by *S*, *O* and *O′* (this is not strictly accurate, but very close to the truth when the secondary waves are small compared to the main wave, as will be seen by comparing the vector diagrams of amplitudes from *S*, *O*, *O′* and *S*, *O* alone), and all three images must be reproduced. As Dr. Gabor has shown, this is just what is observed when the experiment is tried. By altering the focus of the eyepiece, one sees at first *O* in focus against a bright background, then the source *S*, and finally the reversed image *O′* on the far side of *S*. We cannot see *O* without at the same time seeing a diffuse image *O′* out of focus behind it; this is the price paid for being unable to record phases. If, however, *O* is an object such as a narrow opaque line on a transparent background, the ideal case for the Gabor method, the image *O′* is almost invisible when out of focus. The method fails when *O* has large opaque areas, as these do not disappear when out of focus.

The principle of the method is identical with one familiar in X-ray analysis of crystals. Diffracted intensities are alone recorded, whereas to form a Fourier representation of the crystal structure one needs to know both amplitudes and phases. In certain favourable cases of centro-symmetrical projections there are atoms of such high atomic numbers at the cell-corners that all phases are zero, the other atoms merely altering the amplitude (for example, J. M. Robertson's analysis of platinum phthalocyanine[2]). The Fourier series can then be formed. The heavy atom corresponds to the source *S*, and the remaining atoms to *O* and *O′* in Gabor's method.

An even closer analogy is provided by the analysis of cholesteryl iodide by C. H. Carlisle and D. Crowfoot[3]. The crystal has no centre of symmetry. If the Fourier series is summed with phases appropriate to the heavy iodine atoms alone, it is equivalent to assuming a centre of symmetry and so phases of 0 or π. The Fourier series, therefore, shows both the actual molecule in the cell and its reversed image, corresponding to *O* and *O′* in Gabor's reconstruction.

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Delayed Particles in Extensive Air Showers

AN attempt has been made, using two different experimental arrangements, to detect delayed particles in extensive air showers. In the first experiment (carried out under a thick concrete roof at University College, Dublin) extensive showers were selected by coincidences of three trays of Geiger–Müller counters, each tray of area 750 cm.^{2}. The trays were placed at the apices of a triangle of sides 5·3, 7·3 and 8·5 metres. Pulses from a fourth tray of area 360 cm.^{2} occurring 1·4–11·4 μsec. later were recorded.

In the second experiment showers were selected by two trays (*A* and *B*) each of area 1,500 cm.^{2}, horizontally separated by 2 m. Counts from a third tray, *C*, also of area 1,500 cm.^{2}, which occurred 1·5–6·5 μsec. afterwards, were recorded. Undelayed coincidences *A*, *B*, *C* were also recorded. In the first part of this experiment, tray *C* was unshielded; later, it was shielded by 20 cm. of carbon, and finally, with its area reduced to 600 cm.^{2}, it was shielded by 20 cm. of lead. This second experiment was per-

Arrangement	Rate of 3-fold undelayed coincidences per hr.	Time	No. of delayed events	Rate of delayed events per hr.	Expected rate of spurious delayed events per hr.
1st experiment	2·8 ± 0·08	375 hr.	0	0	0·001
2nd experiment *C* unshielded; area = 1,500 cm.^{2}	45 ± 4	3 hr.	0	0	0·14
C shielded by 20 cm. of carbon; area = 1,500 cm.^{2}	30 ± 1	18 hr.	2	0·1 ± 0·07	0·14
C shielded by 20 cm. of lead; area = 600 cm.^{2}	1 ± 0·14	50 hr.	2	0·04 ± 0·028	0·04

formed under a light roof. The results of both experiments are given in the accompanying table.

It will be seen that in all cases the expected rate of spurious event is equal to or greater than the rate of delayed events recorded. Thus, in these experiments no evidence was found under a variety of conditions for particles delayed by more than 1·5 μsec. in air showers. It is unlikely that the fraction of delayed particles, if they occur, is greater than 5 per cent in any case.

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Thixotropy and Electrical Behaviour

The dynamical methods commonly employed in rheological measurements for determining thixotropic changes in pastes and non-Newtonian fluids are inadequate owing to the superimposition of the shear and time effects. However, in a system comprising an electrically conductive disperse phase, the processes of deflocculation under shear and reflocculation to a more or less connected skeletal structure during subsequent rest can be followed by conductimetric methods. Thus, a paste of carbon black in non-polar mineral oil exhibits a degree of electrical conductivity at any given stage of its rheological history which is in conformity with its rigidity and its appearance under the microscope.

With deflocculating media such as the polymerized oils used in printing inks, the specific conductivity of the paste may approach the low value characteristic of the medium itself and show very little growth of conductivity on prolonged ageing. In general, good printing inks comprising electrically conducting high-grade carbon blacks exhibit such low conductivities after shear that these are not measurable even with a condenser and ballistic galvanometer, small readings only being possible after a rest of several days. Nevertheless, the rigidities of such materials as determined with a delicate form of parallel-plate plastometer increase threefold and mobilities decrease more than fivefold during this period of rest after shear. When diluted with aromatic hydrocarbons, they form permanent colloidal sols of carbon black, which makes it evident that such dispersions comprise unlinked, independent and hence deflocculated particles. There is then in these latter systems a type of rheological thixotropy which is not based on a change of spatial arrangement of solid dispersate, and further investigation is needed to determine whether or not the underlying mechanism is due to a sol-gel transformation of the quasi-liquid interstitial layers.

In the absence of dipolar constituents in the medium forming a normally flocculated system, there is no evidence of cataphoresis after deflocculation by shear; nevertheless, maintenance of E.M.F. during the rest period greatly accelerates the growth of conductivity. The appearance of the material under the microscope when in an electric field confirms the latter observation; a 'lines-of-force' structure between the electrodes resembles in appearance iron filings in a magnetic field.

It has been claimed that a change of dielectric constant, based on capacitance measurements of thixotropic materials, has been observed under the respective conditions of shear and rest. While the determination of pure capacitance of non-conductive systems offers no difficulties, the results are misleading when there is ohmic conductance, and indeed measurement becomes nearly impossible when conductance grows during the observations. Systems comprising media and powders which exhibit virtually no conductivity, for example, dispersions of zinc oxide, rutile titanic oxide, etc., in liquid paraffin, show capacitances differing little from that of the pure medium, and although showing little or no drift of readings with time after thorough shear, may yet exhibit high rigidities and be, moreover, markedly thixotropic. The non-conductive printing ink systems referred to show very little increase of capacitance during their period of thixotropic regain of rigidity; indeed, this increase is often only recognizable by development of a slight loss of sensitivity of the recording instrument ('electric eye'). Hence it would appear that the large changes in 'capacitance' that have been recorded as evidence of thixotropy should rather be regarded as changes in the impedance of the system.

Work is proceeding on the quantitative aspect of these conductivity measurements.

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Departure from the Rayleigh Law of the Magnetization of a Ferromagnetic Material

Experiments have recently been carried out on the discontinuous changes in magnetization, as shown by the Barkhausen effect, in iron and nickel in the region where the Rayleigh law,

$$I = aH + bH^2,$$

holds. A very small number of Barkhausen discontinuities, so few as not to be reproducible, appeared in this region, followed by a sudden rapid increase in the number at the point where the law ceased to be obeyed. Results on a specimen of annealed iron, where the Rayleigh law ceases to hold for an applied field of about 0·38 oersted, illustrate this. As the applied field increased from zero up to 0·36 oersted, the number of discontinuities observed varied from 21 to 114: between 0·36 and 0·40 oersted the number lay between the limits 247 and 274.

It was noted that, for an applied field of ± 0·38 oersted, the hysteresis energy loss was 1·60 ergs/c.c./cycle, showing that irreversible changes in magnetization must have taken place in the Rayleigh 'region' despite the fact that so few Barkhausen discontinuities were observed. A further interesting point was that in the Rayleigh region some discontinuities were observed in the opposite sense to that expected, indicating a *decrease* in magnetization.

The magnetic characteristics of the materials used are shown in the accompanying table, where H_c is the coercive field, H' the field at which the Rayleigh law ceases to hold, and W_H the hysteresis energy-loss for limits of applied field $\pm H'$.

Néel[1] has given an explanation of the Rayleigh law in terms of small movements of the domain

Material	H_c (oersted)	a	b	H' (oersted)	W_H (ergs/c.c./cycle)
Iron (annealed)	1·05	15·5	19·5	0·38	1·60
Iron (hard drawn)	6·8	6·5	1·45	2·2	21·5
Nickel (annealed)	1·2	9·8	39·5	0·32	2·0
Nickel (un-annealed)	10·5	1·2	0·050	4·3	10·5

boundary walls due to the action of the magnetizing field, the wall energy depending on irregular perturbations in the magneto-crystalline energy. He has shown that there are reversible movements of the wall leading to a reversible magnetization, aH, and irreversible movements giving elementary hysteresis loops, the magnetization changing by $\pm bH^2$.

The energy perturbations have been attributed to magnetostrictive strains, or strains due to inclusions of foreign atoms, or both, and various workers[3,4,2] have used these ideas to explain the mechanism of the coercive field, this field having a value such that the domain wall is just able to move past the largest energy 'obstacle' it encounters as it changes its position.

An explanation, in the framework of these theories, of the effects described above is as follows.

In the Rayleigh 'region' the irreversible wall movements, which are small, give the irreversible magnetization and hence the Barkhausen discontinuities. These, however, are in general too small to be detected with the apparatus used[5]. As soon as the field reaches a value such that the domain wall can pass by the largest 'obstacle' in its path, it will move a comparatively large distance, and there will be a discontinuous increase in magnetization larger than is indicated by the Rayleigh law. In a polycrystalline material, this will take place when the 'critical' value of the applied field has been reached in any of the domains into which a particular crystal grain is divided. The magnetization increases more rapidly than the law predicts, and an appreciable number of Barkhausen discontinuities, large enough to detect, are observed. The coercive field will be a mean value of all the 'critical' fields involved. The values of the 'critical' fields will depend on the particular energy variations in the domains and on the orientation of the crystal axes of the various grains. The coercive field will thus be larger than the *minimum* value of the 'critical' field, indicated by H', the value of the magnetizing field at which departure from the Rayleigh law occurs (see table).

H', therefore, indicates a region where there is a transition from the small irreversible changes in magnetization in the Rayleigh 'region', to larger irreversible changes due to the action of the 'critical' field in the manner outlined above.

These investigations are being extended, and it is hoped to publish a detailed account of them in due course.

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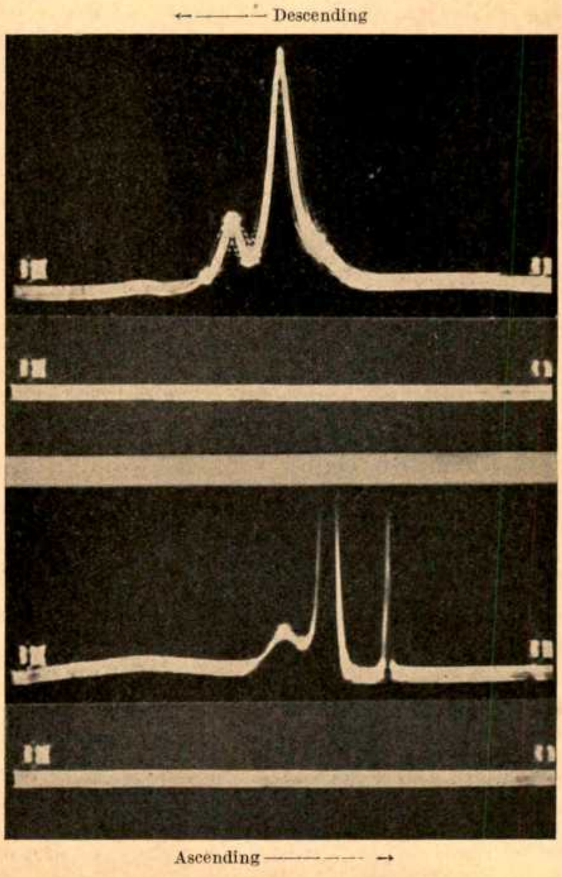
Reference Wedge for *Schlieren* Diagrams

One necessity for the quantitative analysis of *Schlieren* diagrams, as obtained by the Thovert–Philpot–Svensson cylindrical lens method[1], or the Longsworth *Schlieren* scanning method[2], is the precise definition of the base-lines. Although it is common practice to photograph a base-line obtained through a by-pass simultaneously with the pattern, details near the base-line may easily be covered up, and furthermore an uncertainty in the position of the base-line may be introduced, since the patterns of base-lines obtained from two different places in the plane of the cell cannot be expected to appear in exactly the same position. Another accepted technique consists in superimposing the base-lines taken through the channels of the cell at the beginning of the run upon the tracings of the final patterns, so that those parts which do not show an elevation coincide. It is, however, a frequent occurrence, in electrophoresis experiments, for example, that a pattern spreads out to such an extent that no part of it can be considered to indicate the position of the true base-line. The device described here permits analysis in cases such as this, while in all others it provides a useful check.

A glass wedge is mounted beside the channel (diffusion or adsorption analysis), or between the two channels (electrophoresis), and light from the linear light source is allowed to pass through this wedge by two rectangular holes near the ends of the channel. The width of each hole is about half that of the channel. The length is arbitrary and was about 4 mm. in the present arrangement. The wedge has two optically flat surfaces facing the lamp



and the camera, and the angle between them is such that the light is deflected downward and an image of the linear light source is produced at the diagonal slit about 5 mm. below that obtained through the channels. For example, if the distance between cell and diagonal slit is 2 m., the angle of the wedge is 17′. Two short sections of a displaced base-line appear beside the base-line of the pattern, as shown in the photograph. The displacement of 5 mm. is convenient for the usual changes in refractive index, such as are given by protein concentrations of 1–3 gm./100 ml., when a cell depth of 25 mm. is used. It is also well adapted for small changes in refractive index when very shallow slit angles are necessary.

The device is primarily designed for use with a slit in front of the camera; but it is also suitable for a bar or knife edge, if the exposure times are such that the parts of the photographic plate which receive light through both the channel of the cell and the wedge are not over-exposed.

The accompanying reproduction shows the ascending and descending electrophoretic patterns of a muscle protein extract which was electrolysed for a considerable length of time at high salt concentration. Note that the δ- and ε-boundaries have spread beyond the optical field. Correct superposition of the base-lines was achieved with the guidance of the reference-lines, which were made to coincide.

In order to obtain points of reference along the vertical direction, which are necessary for the determination of migration velocities from photographic records, horizontal wires are placed across the rectangular slits of the wedge mount. They appear in the photograph as vertical lines across the reference base-lines. The illumination on both sides of such lines is equal, and so their positions are not shifted by varying exposure or development times.

I wish to thank Prof. W. R. Amberson for facilities for experiment and for permission to publish two of his diagrams, and Miss Carolyn Stout for discussion and assistance. I am also indebted to the authorities of the London Hospital Medical College for granting me leave of absence. The wedge was made by, and may be obtained from, the Baltimore Instrument Company, Baltimore, Maryland, U.S.A.

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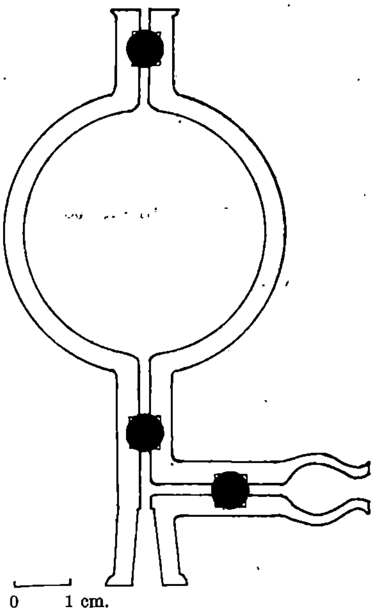
Pipetting Device for use with Radioactive Solutions

In a German army field laboratory apparatus, we ave found a pipetting device for use with noxious quids which should prove a more efficient means of andling radioactive solutions than the branched ipettes described by Swallow[1] and Gardner[2].

The device consists of a hollow rubber ball (5 cm. iameter) with two rubber tubes at opposite poles, ich tube being closed with a valve. One tube is pered internally to grip pipettes of different sizes; ttached to this tube, between the valve and the pered part, is a side-arm which also contains a lve and which has a dilatation to grip the expanded d of a gas-trap. X-ray photography has shown that these valves consist of a glass ball contained within a regularly shaped cavity, and the valves remain air-tight until flats over the glass ball are squeezed with the fingers. The suction obtainable is sufficient to fill a 25-ml. pipette; by appropriate movements of the valves a larger pipette can be filled. Delivery is permitted by opening the valve of the side-arm, and the control of flow of the liquid is better than with the usual method of using pipettes. All operations can be performed with one hand.



Unfortunately, the maker is unknown and the apparatus has not been listed in any British catalogue which has come to our notice.

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Synthesis and Breakdown of Citric Acid with Crystalline Condensing Enzyme

The synthesis of citric acid from acetate, adenosine triphosphate and oxalacetate by soluble enzyme preparations from pigeon liver has been previously reported[1]. The system requires magnesium ions (Mg^{++}) or manganese ions (Mn^{++}) and coenzyme *A* as co-factors. Novelli and Lipmann[2] reported synthesis of citrate in *E. coli* extracts with acetyl phosphate and oxalacetate as substrates. We find that, in this case, at least two enzymes are required (cf. also ref. 3). The first enzyme, (*a*), activates acetyl phosphate; the second, (*b*), catalyses the condensation of 'active' acetate and oxalacetate to citrate. The overall reaction is: acetyl phosphate + oxalacetate = citrate + orthophosphate. Enzyme (*a*) can be obtained from various bacteria (*E. coli, Cl. butylicum, C. fœcalis*) practically free from (*b*). The condensing enzyme (*b*), which is readily soluble, is present in a variety of animal tissues (heart, skeletal muscle, liver, kidney, brain), bacteria (*E. coli, Azotobacter agilis, M. tuberculosis*) and yeast[4].

This enzyme has recently been isolated from pig heart in crystalline form[5] by a procedure involving extraction with dilute phosphate buffer, adsorption and elution from calcium phosphate gel, precipitation with ethanol at − 15°, and ammonium sulphate fractionation. The enzyme crystallizes as slender needles from 50 per cent saturated ammonium sulphate. One unit of condensing enzyme has been defined as the amount required to catalyse the synthesis of one micromole of citric acid in 10 min. at 25° in a system containing *E. coli* extract (as a source of enzyme (*a*) and coenzyme *A*) and the following components (in micromoles per ml. of reaction mixture): acetyl phosphate, 10·5; oxalacetate, 20; magnesium chloride, 4; L-cysteine, 10; and potassium phosphate buffer *p*H 7·4, 25. The initial extracts have an activity of 0·6–1 unit per mgm. of protein. After several recrystallizations the final product has an activity of about 330 units per mgm. Typical results are shown in Table 1.

Table 1. ACTIVITY OF TWICE RECRYSTALLIZED CONDENSING ENZYME

Enzyme (mgm.)	Acetyl phosphate* removed (micromoles)	Citrate synthesis (micromoles)	Specific activity of enzyme (units/mgm.)
0·0041	1·3	1·36	332
0·0082	2·6	2·70	329
0·0123	4·1	4·13	336
0·0164	5·3	5·21	318

* Determined as hydroxamic acid (ref. 6).

Enzyme (*a*) is probably identical with Stadtman's transacetylase[7], which catalyses an interchange of acetyl-bound phosphate with inorganic phosphate in the presence of coenzyme *A*. The condensing enzyme catalyses a slow exchange of acetyl-bound oxalacetate (that is, oxalacetate bound as citrate) with free oxalacetate in the presence of coenzyme *A*. This indicates that the reaction catalysed by this enzyme is reversible, but its equilibrium is far toward citrate synthesis. As shown in Table 2, the oxalacetate exchange is obtained only when small amounts of the keto acid are present, and is markedly inhibited when the oxalacetate concentration is increased. This is probably due to competition between oxalacetate and citrate for an active site on the enzyme.

Table 2. ENZYMATIC EXCHANGE BETWEEN CITRATE AND OXALACETATE CONTAINING CARBON-14

Additions			Counts in oxalacetate per minute	
Coenzyme *A* (units)	Condensing enzyme (units)	Oxalacetate (micromoles)	β-Carboxyl	Carboxyl of residual pyruvate
20	100	40	22	
20	100	10	47	
20	100	2	135	92
20	0	2	26	
0	100	2	3	
20	80	2	114	103

1·0 ml. of reaction mixture containing (in micromoles) phosphate buffer *p*H 7·0, 50; magnesium chloride, 4; L-cysteine, 10; carbon-14 labelled sodium citrate, 20 (31,200 counts per minute); with other additions as indicated, incubated 5 hr. at 25°. Carrier oxalacetate was then added to all samples (except in exp. 1) to make 20 micromoles. The oxalacetate (β-carboxyl) was decarboxylated by heat and the residual pyruvate with yeast carboxylase. The carbon dioxide was collected in alkali and counted as barium carbonate. The condensing enzyme used in the last experiment was twice recrystallized (specific activity 330); the other experiments were conducted with an amorphous fraction of specific activity 110. The radioactive citrate was prepared biosynthetically with *Aspergillus niger* fermenting glucose in the presence of carbon-14 dioxide (ref. 8). Enzymatic degradation of this citrate showed that almost all the radioactivity was present, and about equally distributed, in the two carboxyls of its oxalacetate moiety (730 counts/min./micromole in each carboxyl).

We are indebted to Mrs. Nora Howell and Mr. Tibor Farkas for assistance. The work was supported by grants from the United States Public Health Service, the American Cancer Society (recommended by the Committee on Growth of the National Research Council), the Office of Naval Research, and the Rockefeller Foundation.

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Alkaline Fission of some 2-Substituted Dimethyl-ethyl-sulphonium Iodides

IN a paper published under this title, Crane and Rydon[1] described the behaviour towards alkali of some sulphonium iodides of the general structure, $R.\mathrm{CH_2.CH_2.\overset{+}{S}Me_2\}I^-}$. Among such compounds those in which R was Ph.CO.O— and Ph.O— were remarkably labile, consuming alkali in the cold and decomposing on warming with alkali according to the equation:

$$R\,.\,\mathrm{CH_2\,.\,CH_2\,.\,\overset{+}{S}Me_2\}I^- + 2NaOH} \rightarrow R\mathrm{Na + CH\,:\,CH + SMe_2 + NaI + 2H_2O}.$$

We have been engaged for some time in a further examination of the action of alkali on sulphonium iodides of the type $\mathrm{Ar.CO.O.CH_2.CH_2.\overset{+}{S}Me_2\}I^-}$, and now find that the reaction proceeds in two distinct stages, thus:

$$\text{(i)}\quad \mathrm{Ar\,.\,CO\,.\,O\,.\,CH_2\,.\,CH_2\,.\,\overset{+}{S}Me_2\}I^- + NaOH} \rightarrow \mathrm{Ar\,.\,CO\,.\,ONa + CH_2\,:\,CH\,.\,\overset{+}{S}Me_2\}I^- + H_2O},$$

$$\text{(ii)}\quad \mathrm{CH_2\,:\,CH\,.\,\overset{+}{S}Me_2\}I^- + NaOH} \rightarrow \mathrm{NaI + CH\,:\,CH + SMe_2 + H_2O},$$

of which only the first proceeds at a measurable speed at room temperature under mildly alkaline conditions (*p*H *c.* 10). Crane and Rydon[1] stated that both stages took place in the cold, no doubt owing to a misunderstanding arising from the circumstance that their work was written up for publication some years after it had been completed, under conditions of some urgency, as part of a war-time study of the mode of action of mustard gas. Accordingly, their theoretical interpretation of this reaction, and of the similar one undergone by $\mathrm{PhO.CH_2.CH_2.\overset{+}{S}Me_2\}I^-}$, is invalid, although the remainder of their experimental work still stands.

We have studied the rather remarkable elimination reaction (i) with a series of substituted benzoyloxyethyl dimethyl sulphonium iodides, $X.\mathrm{C_6H_4.CO.O.CH_2.CH_2.\overset{+}{S}Me_2\}I^-}$, by continuous titration with alkali in the apparatus of Powell and

Trendall[2]. The reaction is first-order with respect to both hydroxyl and sulphonium ion, and we have obtained the following bimolecular velocity constants for 0·005 *M* solutions of the various sulphonium iodides in water at 25°:

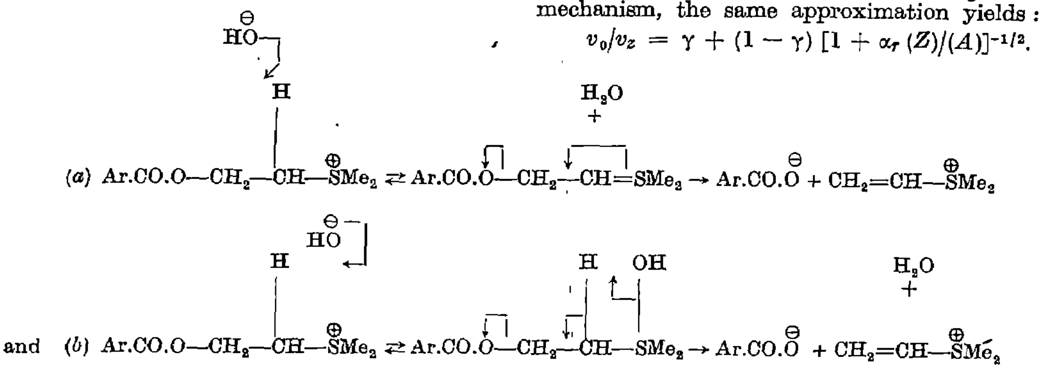
X	*p*-MeO	*o*-MeO	*p*-Me	*o*-Me	H	*p*-Cl	*o*-Cl	*o*-NO_2	*p*-NO_2
k_2(mol./litre/min.)	211	291	319	314	356	476	673	1242	1611

Clearly the reaction is facilitated by electron-attracting substituents *X*. There is no obvious indication of the operation of the ortho-effect, which is only what is to be expected if the hydroxyl ion attacks at or near the positively charged sulphur, which is far removed from the aromatic nucleus. The plot of log k_2 against Hammett's σ-values for *p*-substituents is as linear as usual ($\log_{10}k_2 = 2{\cdot}562 + 0{\cdot}825\,\sigma$), and the apparent absence of any ortho-effect emboldens us to deduce the following σ-values for *o*-substituents:

X	*o*-MeO	*o*-Me	*o*-Cl	*o*-NO_2
σ	− 0·120	− 0·080	+ 0·320	+ 0·645

These values are put forward with some reserve, since the reaction shows a negative salt effect which is greater than would be expected on the basis of the Brønsted equation[3]; they are, nevertheless, probably quite near to the truth.

The occurrence of this reaction cannot be ascribed solely to the presence of a positive pole, since it is not shown by the nitrogen analogue, $\{Ph.CO.O.CH_2.CH_2.\overset{+}{N}Me_3\}I^-$. This suggests that the neutral intermediate indicated by the negative salt effect may have a structure in which the sulphur carries an electron decet; such a structure is, of course, impossible for nitrogen but possible for phosphorus, and we hope to examine the phosphorus analogue. We find, too, that similar alkali-lability is shown by the sulphone, $Ph.CO.O.CH_2.CH_2.SO_2.Me$, but not by the sulphoxide, $Ph.CO.O.CH_2.CH_2.SO.Me$. Two possible mechanisms are:



Both these fit the available data, and we cannot at present distinguish between them. Our investigation is being continued and will be reported fully elsewhere in due course.

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Inhibition of the Homogeneous Thermal Decomposition of Acetaldehyde by Chemically Inert Gases

It is possible to make a classification of all the different types of mechanisms which correspond to a given order of the initial rate of the homogeneous gas phase thermal decomposition of simple organic compounds[1] if a free-radical chain mechanism is admitted. These types of mechanisms differ in two ways: (*a*) in the type of radicals which takes part in the chain-breaking step, which can be a bimolecular reaction or a triple collision; and (*b*) in the chain-initiating step, which can be monomolecular or bimolecular.

It would be expected that in any of these cases chemically inert gases could influence the reactions: acting as a partner in chain-breaking triple collisions, they can decrease its rate; or they can increase it by serving as an activating partner in chain-initiating bimolecular collisions. From the equations previously given[1], it is easy to show that if v_0 is the initial rate in a pure vapour at the concentration (A), and v_z in the presence of a concentration (Z) of an 'inert gas', the ratio v_0/v_z depends on (1) (Z) only, if, in the absence of *Z*, chain-initiation is monomolecular and chain-breaking bimolecular; (2) $(Z)/(A)$ only, if, in the absence of *Z*, chain-initiation is bimolecular and chain-breaking termolecular; (3) (Z) as well as on $(Z)/(A)$, if, in the absence of *Z*, chain-initiation is bimolecular and chain-breaking bimolecular (or monomolecular and termolecular).

Although the exact relationship between v_0/v_z and (A) and (Z) is complicated, a reasonable approximation gives, for case 2:

$$(v_0/v_z)^2 = [1 + \alpha_z(Z)/(A)]/[1 + \alpha_i(Z)/(A)], \quad (1)$$

where α_r and α_i are the relative collision efficiencies *of Z compared to A in chain-breaking or chain-initiating steps.*

If a fraction γ is decomposed according to a molecular mechanism, and 1 − γ according to a chain mechanism, the same approximation yields:

$$v_0/v_z = \gamma + (1 - \gamma)\,[1 + \alpha_r\,(Z)/(A)]^{-1/2}. \quad (2)$$

For acetaldehyde, M. Letort[2] had shown that v_0 is of the order $n = 3/2$. This result has been confirmed recently[3], and there is no reason for believing that the measured kinetics is influenced by minute traces of oxygen or peroxides[4], since samples, of which proportions between 30 and 70 per cent had been decomposed in previous runs, decompose at exactly the same rate as fresh, thoroughly purified samples.

We have now shown that chemically inert gases such as carbon dioxide, hydrogen and nitrogen decrease the initial rate, as had been shown already for carbon monoxide and mixtures of carbon monoxide and methanes by Letort[2]. The accelerating effect of hydrogen observed by various authors[5], and of carbon dioxide observed by J. R. E. Smith[6], is probably attributable to the presence in those gases of traces of oxygen, which strongly accelerates the thermal decomposition of acetaldehyde[2,7].

The non-dependence of v_0/v_Z on (Z), for constant $(Z)/(A)$ ratios, can be clearly demonstrated by experiment, and the results agree well with equation 1.

The calculated relative efficiencies are:

Z	Carbon dioxide	Carbon monoxide and methane	Hydrogen
a_i	very small	0·06	very small
a_r	0·20	0·33	0·41

These results of inhibition prove the existence of a chain mechanism. Although they do not exclude the possibility of a simultaneous molecular mechanism, they show that the proofs as yet given are insufficient, since equation 1 yields an 'inhibition limit' as well as equation 2.

On the other hand, relation (2) shows that these reactions are initiated by a bimolecular step and that the chain-breaking step is termolecular. There are data in the literature which suggest[8] that this is also the case for other reactions; but the application of conclusive tests would be desirable.

It should be noticed that the results of J. R. E. Smith and C. N. Hinshelwood[9] concerning the retarding effect of propylene on the pyrolysis of acetaldehyde can be expressed formally by the same relation (1) (with $\alpha_i = 7$ and $\alpha_r = 40$) as the retarding effect of carbon dioxide, carbon monoxide and methane. This formal analogy might be ascribed to the fact that a termolecular process of recombination of two free radicals R' and R'' is kinetically indistinguishable from the sequence of processes:

$$R' - \; + \; M \rightleftharpoons R' - M$$
$$R' - M \; + \; R'' \rightarrow R'R'' \; + \; M,$$

when the addition complex $R' - M$ has a sufficiently short life-time.

The considerations here presented will be developed later elsewhere (*Bull. Soc. Chim. Belg.*, in the press).

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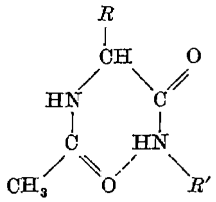
Near Infra-Red Spectra of Proteins and Related Substances

IN addition to the extended configuration of a polypeptide chain, we have proposed a bent or folded configuration, and tried to explain the experimental data of proteins by the various combinations of these two basic configurations[1]. The experimental proof for the existence of the bent configuration of the molecule of acetylglycine anilide (I) afforded evidence

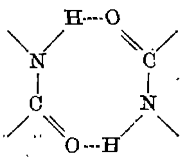


$\left(\begin{array}{l} R \;= \text{H or } CH_2CH(CH_3)_2, \\ R' = CH_3 \text{ or } C_6H_5 \end{array}\right)$

I

in support of our view[2]. The same results have since been obtained for acetylglycine N-methyl amide, acetylleucine anilide and acetylleucine N-methyl amide: namely, in very dilute carbon tetrachloride solutions, these substances exhibit two characteristic absorption peaks, one at 3,450 cm.$^{-1}$ arising from the NH-group in the free state, and the other at 3,330 ~ 3,360 cm.$^{-1}$ from that involved in the intramolecular hydrogen bonding. (These experiments were carried out with Sugita, Kato and Kondo of this Laboratory and the details will be published elsewhere.)

According to our measurements, as well as those of other investigators[3,4], proteins exhibit two absorption peaks, at 3,290 ~ 3,330 cm.$^{-1}$ and at 3,080 ~ 3,090 cm.$^{-1}$, arising from the hydrogen-bonded NH-groups; salmin exhibits the third peak at 3,240 cm.$^{-1}$ arising from the side-chain. The fact that the dipeptides mentioned exhibit only one absorption peak arising from the hydrogen-bonded NH-group is due to the free state of their molecules in dilute solutions. Owing to the low solubility of these substances in carbon tetrachloride, we could not measure the absorptions in concentrated solutions where the state of hydrogen bonding is more akin to that of proteins. In compounds containing one peptide bond, such as N-methyl acetamide, however, we were able to carry out measurements not only in concentrated solutions, but also in the liquid and solid states, and we observed the two absorption peaks of practically the same frequencies as those of proteins. It should be noted that the peptide bond of these compounds is always in the *trans* configuration, as is the case in protein models proposed by us[5]. When the peptide bond is nearly in the *cis* configuration, as in the case of δ-valerolactam, ε-caprolactam, diketopiperazine, etc., the absorption peaks are observed at 3,210 ~ 3,240 cm.$^{-1}$ and at 3,070 ~ 3,100 cm.$^{-1}$. Therefore, the peptide bonds in the main chain of polypeptide cannot be considered to be in the *cis* configuration, and the hydrogen bond of the type shown would not be formed between two main chains of polypeptides.



Darmond and Sutherland also measured the NH-frequencies of compounds containing peptide bonds, but arrived at a conclusion different from ours[3]. They consider that the 3,280 cm.$^{-1}$ band arises from a structure different from that to which they assigned the 3,060 cm.$^{-1}$ band. However, as stated above, such two bands can arise from a single structure in the case of N-methyl acetamide, δ-valerolactam and ε-caprolactam in solutions, and acetanilide and diketopiperazine in the solid state. The proof that each of these substances has a single molecular configuration which is associated in a single way is given by the measurement of the Raman effect, infra-red absorption or dipole moment (N-methyl acetamide, δ-valerolactam and ε-caprolactam)[5], and by X-ray diffraction experiments (acetanilide[6] and diketopiperazine[7]). For the dimer of carboxylic acids, it is also known that more than one O—H vibration arises from a single structure[8]. Therefore, the appearance of more than one NH-stretching frequency cannot be used as a proof of the existence of more than one type of hydrogen bond, and the objection of Darmond and Sutherland to the structure of α-keratin proposed by us[1] and independently by Ambrose *et al.*[9] is not supported by our infra-red measurements.

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Takehiko Shimanouchi
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March 11.

[1] Shimanouchi, T., and Mizushima, S., *Kagaku*, **17**, 24 (1947); *Bull. Chem. Soc. Japan*, **21**, 1 (1948). See also *Chem. Abst.*, **43**, 8843 (1949).

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Locus of the Gene 'Fidget' in the House Mouse

In an attempt to place 'fidget' (symbol *fi*), described by Grüneberg[1], on the chromosome map of the house mouse, *Mus musculus*, a multiple test-cross has been made recently in this Department.

There is now adequate evidence that the locus f this gene is linked with that of Danforth's 'short ail' (symbol *Sd*). Coupling back-cross data give a ecombination value of about 25 per cent, the χ^2 on ndependent segregation being more than 50 for one egree of freedom. Owing to the poor viability of the enotype *Sd* + *fifi*, this member of the cross-over ass is slightly deficient, and the recombination value may, in fact, be somewhat higher. Due to this cause so, there has been some delay in making up reulsion back-crosses. These, however, will shortly be vailable. Full data on the linkage so far indicated will be given as soon as balanced coupling and reulsion data have been produced.

The linkage of *Sd* and *fi* extends the mapped ortion of chromosome V. Carter and Grüneberg[2] port a loose linkage of 'fidget' and the 'agouti' locus, of which the latter is already mapped on chromosome V. Data on *Sd* and 'agouti', available in this Department, give evidence of a looser linkage, about 40 per cent recombination; this has been further corroborated by news of D. Kelton's work at Bar Harbor. The order appears, then, to be *Sd*—*fi*—*A*. Work is now in progress in this Department to determine the exact linkage relations between these three loci and those already mapped on this chromosome.

M. E. Wallace

Department of Genetics,
University of Cambridge.
May 13.

[1] Grüneberg, H., *J. Genet.*, **45**, 22 (1943).

[2] *Heredity* (in the press).

Fertilization of the Rat Egg

The use of the phase-contrast microscope for the study of certain stages in the fertilization of rat eggs has been described[1]. It was pointed out that pressing the eggs beneath a coverslip greatly improved the visibility of the internal structure. More recently, it has been found that, if the Fallopian tubes are dissected under liquid paraffin and the eggs transferred to a slide with some of the fluid which surrounds them while in the Fallopian tube, they would survive for several hours even when pressed beneath a coverslip. During this period the changes involved in fertilization proceeded in an apparently normal manner, and could readily be observed and photographed.

The time of survival differed with individual eggs and also with the degree of pressure to which they were subjected, but was usually not less than six to eight hours or more than twelve to sixteen hours. Within limits, the more the eggs are compressed the greater is visibility improved; but survival, and the occurrence of certain of the changes, are apt to be interfered with if the vertical thickness of the vitellus is reduced to less than about 15 μ. The optimal thickness seems to be about 20 μ.

Under the conditions described, it has been possible to observe in detail, and to photograph, the occurrence *in vitro* of the following complete series of changes: (*a*) the detachment of the sperm head and the conversion of its substance, with the exception of the apical cap or acrosome, into the male pronucleus; the acrosome remains unchanged and is recognizable in eggs recovered at later stages; (*b*) the changes in the second maturation spindle consequent upon sperm penetration as far as the formation of the female pronucleus; (*c*) part of the growing phase of the pronuclei; (*d*) the sequence of events from the conjugation of the pronuclei to the formation of the two-cell nuclei; as yet, however, the actual division of the cytoplasm to form a two-cell egg has not been found to occur under the conditions employed.

These observations and photographic records, together with data on the time relations of the stages of fertilization *in vivo* as well as *in vitro*, are being prepared for publication.

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Glebe, N.S.W.
April 27.

[1] Austin and Smiles, *J. Micr. Soc.*, **68**, 13 (1948).

FORTHCOMING EVENT

Monday, September 4

Association for the Study of Animal Behaviour (at the Royal Society of Tropical Medicine, 26 Portland Place, London, W.1), at 5 p.m.—Prof. Karl von Frisch: "Methods of Communication in the Honey Bee".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMISTS in the Ministry of Supply Chemical Inspectorate, primarily for analysis of materials associated with atomic energy production, including radio-active materials, and development and application of up-to-date physico-chemical techniques and equipments—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.486/50A (September 9).

LECTURER (honours graduate with good qualifications in physical chemistry) IN CHEMISTRY, up to Special Degree standard—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (September 9).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING (Electronics)—The Registrar, The University, Liverpool (September 9).

LECTURER IN RADIO COMMUNICATION—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4 (September 9).

SENIOR ASSISTANT IN THE ELECTRICAL ENGINEERING AND PHYSICS DEPARTMENT—The Secretary, Poplar Technical College, Poplar High Street, London, E.14 (September 9).

SENIOR ASSISTANTS IN THE DEPARTMENTS OF MECHANICAL AND CIVIL ENGINEERING at the Bradford Technical College—The Director of Education, Town Hall, Bradford (September 9).

ASSISTANTS IN EXPERIMENTAL AND THEORETICAL PHYSICS—The Secretary, The University, Aberdeen (September 10).

SCIENTISTS, Grade III (with a good honours degree in chemistry, preferably with some experience of, or special interest in, investigational work on chemical analysis, in the Board's Coal Survey Laboratories at Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/244 (September 11).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering or an equivalent qualification) in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3233 (September 12).

ASSISTANT LECTURER or LECTURER IN GENERAL BACTERIOLOGY IN THE DEPARTMENT OF BOTANY—The Registrar, University College, Cathays Park, Cardiff (September 16).

ELECTRONIC ENGINEERS and PHYSICISTS (Experimental Officer grade) at Ministry of Supply Research and Development Establishments in the South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.253/50A (September 16).

LECTURERS (with a degree in electrical engineering, or an equivalent qualification) at the R.E.M.E. Training Centre, Arborfield, under the War Department—The Under-Secretary of State, War Office (M.E.1), London, S.W.1 (September 16).

PHYSICISTS (Scientific Officer grade) (with a first- or second-class honours degree in physics and good general electronic knowledge and experience) at Ministry of Supply Research and Development Establishments near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.234/50 (September 16).

PILE CONTROL ENGINEERS (Engineer III), at the Atomic Energy Establishment, Harwell, for the operation of heavy nuclear energy plant, mainly of a mechanical nature, requiring some knowledge of instrumentation and control—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.444/50A (September 16).

SCIENTISTS (honours graduates with experience in medical or veterinary research) at a Ministry of Supply Research Establishment in South-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.231/50 (September 16).

CARTOGRAPHER (with a good honours degree in geography, mathematics, physics, engineering, or geology, or a kindred subject, or an equivalent qualification) in the Hydrographic Department of the Admiralty—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3265 (September 21).

LECTURER IN SHEEP HUSBANDRY in the New South Wales Department of Technical Education—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (September 28).

LECTURER IN GEOLOGY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

LECTURER or SENIOR LECTURER IN FLUID DYNAMICS at the University and Hobart Technical College, Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

LECTURER IN ECONOMICS at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 13).

LECTURER IN PHYSICS at Rhodes University College, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

AGRONOMISTS (with a degree in agriculture), an ENTOMOLOGIST (with a degree in science, including entomology as a major subject), and a BIOCHEMIST (with a specialized honours degree in chemistry and post-graduate experience in biochemistry, particularly plant biochemistry)—The Secretary, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia.

ANALYST (preferably experienced in the analysis of non-ferrous metals and alloys)—The Research Manager, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

BURSARY for fundamental research on the physical chemistry of reactions of importance in iron and steel making, tenable with the Nuffield Research Group in Extraction Metallurgy at the Imperial College of Science and Technology—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

DEMONSTRATOR IN BOTANY, with special qualifications in bacteriology—The Registrar, The University, Nottingham.

FIELD OFFICERS by the East African High Commission for the Desert Locust Survey, to organize locust destruction work in desert and semi-desert areas in East Africa and Arabia—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/26874/3A.

INSTRUMENT ENGINEERS (with a good honours degree in mechanical or electrical engineering or physics), by the Division of Atomic Energy (Production), Capenhurst Factory, Chester, to be responsible for the maintenance of physical and electronic instruments used in chemical process control—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

MEDICAL ENTOMOLOGIST (male), for duties in connexion with field investigation into the entomological aspects of communicable diseases, in H.M. Colonial Service, Uganda—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27215/45.

REGIONAL TRIALS OFFICER (with a university degree or diploma in agriculture and/or biology and previous experience of conducting field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

REPORTS and other PUBLICATIONS

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Hannah Dairy Research Institute. Bulletin No. 9: The Effects of Temperature, Humidity, Air Movement and Solar Radiation on the Behaviour and Physiology of Cattle and other Farm Animals; a Review of Existing Knowledge. By Dr. J. D. Findlay. Pp. 178. (Kirkhill: Hannah Dairy Research Institute, 1950.) 6*s*. net. [107

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SCIENTIFIC RESEARCH AND THE BRITISH ECONOMY

IN his recent book "Co-operative Industrial Research", Prof. R. S. Edwards attempts to assess the contribution which the research associations are making to industrial development and to the application of existing, or of new, knowledge. An article by a young American economist and man of science, Mr. R. L. Meier, who has some experience in the United States in fundamental and applied research, has since been published in "The Manchester School of Economic and Social Studies". This article attempts to assess the extent to which science is utilized in the British economy and the value of the fundamental research at present being carried out in Great Britain. Mr. Meier claims that his judgments are based on his experience both in the United Kingdom and in the United States and on intimate contacts with current developments in physics, chemistry, ferrous metallurgy, biology and electrical engineering. Internal evidence may suggest some scepticism as to this rather large claim; but, when all due allowance has been made for personal limitations, there is much in Mr. Meier's paper that is instructive and indeed suggestive, and he has a perspective that is rarely found in the voluminous literature on industrial research.

Dealing first with the economic value of research, Mr. Meier points out that for certain categories of research it is impossible to supply economic standards of value, and the time-lags which are involved and the indirect uses to which the new knowledge is put tend to confuse any economic analysis. Some research must be treated as an operating expense, some as part of the capital investment which is amortized over a period of years, and some as part of an inexhaustible resource. Even where the research is expected to yield an economic return, and where the goals of the projects are explicit and the time-lag between outlay and the prospect of income no more than five to ten years, the uncertainty in evaluating the return may be more than ± 50 per cent.

Mr. Meier suggests that the evidence indicates that it has been good business to expand and re-equip industrial research both in Great Britain and in the United States. On the basis of figures available for the United States, he suggests that from the national point of view, for every dollar put currently into research, three dollars are obtained as a result of making use of past research, and that for each dollar expended upon research in the United States economy, about ten dollars of net saving are required. Nevertheless, there are limits to the extent to which research can wisely be prosecuted, imposed by the availability of suitably trained men of high intellectual calibre, the availability of capital and the receptivity to changes in patterns of trade.

Mr. Meier warns us against attempting to remake the British economy in the North American image; but, with that warning in mind, his analysis of trends in fundamental research in Great Britain, based in part on the sampling of notes or letters appearing in one week's issue of *Nature*, is the most interesting part of his paper. Some of his conclusions are in sharp contrast with Sir Hubert Henderson's view that the distinction between fundamental and applied knowledge can be overstressed, and that he knew nothing more impressive in the history of the development of human thought than the advances that have been made by a constant interplay between abstract analysis and the attempts to solve particular problems. Assuming that the productivity of applied scientists and development engineers is the same everywhere, Mr. Meier concludes that the United States will benefit about three times as much from current British research as does the whole sterling area; and this judgment takes no account of the fact that shortages of materials, instruments and imperfect organisation make the productivity of applied research in Great Britain considerably lower than in the United States.

Other considerations have also led Mr. Meier to the conclusion that British fundamental research is of far more value to the United States than it is to the sterling area, although, in spite of the elegance of the contributions of British science, they make little difference to the massive economy of the North American continent. Most fundamental research, he suggests, is of the sort that, if it is not done this year, would be done elsewhere in a few years. He claims, indeed, that the highest class of British fundamental research, ordinarily measured by the originality of conception and the reproducibility of results elsewhere, works to the detriment of the trade balance between the sterling areas and the hard-currency areas, and that its marginal value, as it is at present organised, is very negative, being probably between two or five times the total marginal cost of salaries, equipment and overheads.

Mr. Meier admits that this judgment is based upon the experience of one individual, and his conclusions are unlikely to pass without challenge. Nevertheless, he states that he has failed to discover a single instance, except perhaps in the jet project as a whole, where British development of their own fundamental research would bring a substantial reward in terms of foreign markets or rights. The view that very little of the fundamental research in Britain is relevant to the existing capacity to apply it so as to benefit the home economy, although much of it is relevant to applied research carried out in the rest of the world, is indeed consonant with Sir Henry Tizard's view, expressed in his presidential address to the British Association in 1948, that it is not the general expansion of research in Britain which is of first importance for the restoration of its industrial health but the application of what is already known.

What follows from Mr. Meier's analysis, if sound, is not so much the conclusion that there has been too great an outlay on fundamental science and too little in the applied area, as an implied criticism of the direction of research. Prof. Edwards, in his study of co-operative research associations, avoided any discussion of their inherent capacity to select the right targets. Mr. Meier raises that issue over the whole field of fundamental and applied research, whether conducted by Government research stations or private industry or the universities, and he gives point to his criticism by suggesting new directions for British research and the criteria for choosing the type of programme he advocates. Broadly, he suggests that, by taking advantage of the excellencies and minimizing the deficiencies of both fundamental and applied research in Britain, this section of the economy should be eased into a position where opportunities opened up by fundamental research in other countries are grasped as rapidly as other countries borrow from British findings.

The concrete examples of fields and problems which Mr. Meier suggests, such as jet research, food technology, textile fibres and garments, and metallurgy, are of less general interest than the criteria he indicates for selecting programmes. The field should be such, in his view, that rapid advances can be made with theoretical science, and it should draw upon indigenous resources. It should fill a recognized need and aim at a sterling market as well as export outlets. The overall use of the developments should be very wide so that there are good chances for extensive growth of the newly founded industries; but expansion of a heavily subsidized industry or social service should not be involved unless it is clear that such losses are easily recouped. Research should be so gauged that the first returns can be realized within five to fifteen years. The effort needed to achieve supremacy in a specific avenue of research should not require a major portion of the local talent in this field, since a large share will be needed to handle routine improvements of existing products and seek new opportunities.

What Mr. Meier advocates is primarily a change in the organisation of research, and his paper is a challenge to constructive thought, independently of the extent to which his opinions are accepted. He recognizes clearly enough that the change in organisation and the selection of programmes must be made from within, by those who understand intimately British capacities and susceptibilities. He is aware, too, of the difficulties presented by staff position and particularly by the shortage of technologists—a position which, to say the least, is unlikely to be eased by the fresh demands for defence research foreshadowed in the defence debate on July 26. But, for an American, Mr. Meier is singularly free from the inhibition of government direction which has characterized post-war discussions in the United States of the organisation of research.

It is interesting to put Mr. Meier's conclusions alongside some of the conclusions recorded in the third annual report of the Advisory Council on Scientific Policy*. The Council's study of the reports of the committees of inquiry set up by the Ministry of Labour's Technical Personnel Committee into the supply and demand for qualified men of science and engineers has led it to conclude that, in general, university departments have expanded sufficiently to satisfy the prospective demand, save that continuing shortages are expected of chemists and chemical engineers. Nevertheless, it thinks that Britain should at least maintain the level of output of science graduates which has resulted from implementing the policy advised by the Barlow Committee; and this policy is mainly proposed because the Council believes that, if British industry is to improve or even maintain its present position in the world, it must employ more men of science and engineers both in the conduct of pure research and, still more, in its application.

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* Third Annual Report of the Advisory Council on Scientific Policy, 1949–1950. (Cmd. 7992.) Pp. 18. (London: H.M. Stationery Office, 1950.) 6*d*. net.

The Advisory Council refers, in particular, to the desirability of appointing men of science with administrative ability more extensively to leading executive positions, as well as to the use of scientific workers of lesser calibre in a wider range of technical posts. Nevertheless, the Council has reached no conclusion as to the numbers of higher technologists who are required or can be usefully absorbed by industry. On the man-power side, its sole recommendation is that, as soon as the resources, material and human, can be employed without detriment to the work in applied science which the universities are already doing, it would be prudent to establish one or two colleges of applied science, with suitable governing bodies of their own but fitted into the university system, as an addition, and not as an alternative, to the facilities already provided by the university departments of applied science.

Much nearer to the main theme of Mr. Meier's article, however, are the comments of the Advisory Council on a report submitted to the Lord President of the Council by Sir Ben Lockspeiser on the organisation and administration of the Department of Scientific and Industrial Research. Sir Ben Lockspeiser had been asked to consider how best the Government could "ensure the fullest application of scientific knowledge to the solution of the problems of productivity and economic development". In his report the main objectives of the Department are defined as, first, to ensure that the applied scientific research carried out by the Department is at all times related to the economic problems confronting Great Britain, and that the scientific resources of the Department are applied to those problems the solution of which would most assist the national economy: second, to ensure that the resources of the Department are used so as to make the maximum contribution to improving the efficiency of industry, particularly in relation to productivity, new products and new processes; and third, without subtracting from the responsibilities of production departments and nationalized industries for development, to exert its maximum influence in securing the effective application of the results of its researches.

The Advisory Council's own discussions are concerned mainly with the effectiveness of the research work for the manufacturing industries, whether this is carried out in the Department's own establishment or by the industrial research associations. It concurs in the view that the expansion of research within the manufacturing industries is more important at the present time than the expansion of industrial research by the Government. This view is subject to the qualification that there are many branches of industrial research, such as the maintenance of standards of measurement, which can be effectively and economically advanced only in a central establishment. Some form of centralized research is essential for the many manufacturing industries composed of a large number of small and scattered firms, while there are in most fields of investigation problems the generality of which is such that, though their solutions are essential to the progress of research and development in industry, they are most effectively handled in some central organisation which is at the service of industry.

The Advisory Council's report gives no indication that the particular directions in which research should be prosecuted, or the balance between fundamental and applied research on which Mr. Meier focuses his criticism, have been brought under consideration. It would appear that, for all the Advisory Council's agreement with the view that industrial research, in order to be fully effective, should be carried out by industry itself in close touch with development and production, it is satisfied that no method of enabling firms to undertake collectively research which they would be unable to conduct individually has yet been suggested which is better than that of the research associations. The Council recognizes, however, the need for the critical examination of programmes, with a view to the selection for special attention of items most likely to lead to important practical advances, and would deplore any spirit of complacency regarding the utilization of scientific research in Great Britain.

The inquiries which the Advisory Council has conducted during the past year have, however, left it optimistic about the present condition and future prospects of British science. It does not discuss the particular points which Mr. Meier has raised regarding the place of science in the national economy with reference to the competitive position with the hard-currency countries; and it is satisfied that, if British scientific workers continue to lead the world in the originality and importance of their discoveries and if in future the technology proves adequate to the science, then the conditions of prosperity will be fulfilled. To the extent to which this report admits that any success must depend upon the ability to meet competition by applying scientific knowledge more successfully than one's rivals to the industrial processes by which raw materials are transformed into manufactured goods, the Advisory Council recognizes the force of Mr. Meier's contention as to the extent to which broad economic considerations should determine the selection of programmes and targets in industrial research. Mr. Meier has raised important issues, and, if his answers are not altogether convincing, it is to be hoped that later reports from the Advisory Council on Scientific Policy or from some well-informed authoritative body will deal adequately with the questions he has raised. This fresh challenge to a reassessment of the general direction and distribution of the research effort in Britain from the economic point of view, and not least that of the industrial research associations, is bound to be powerfully enforced by the further stringencies in regard to scientific and technical manpower and materials which will be the inescapable consequence of the new defence programme to which Great Britain has now been driven.

FUNDAMENTAL INDUSTRIAL RESEARCH

Phenomena, Atoms and Molecules: an Attempt to Interpret Phenomena in terms of Mechanisms or Atomic and Molecular Interactions.
By Irving Langmuir. Pp. xi+436. (New York: Philosophical Library, Inc., 1950.) 10 dollars.

At the end of this book is printed a list of the 215 papers which Dr. Irving Langmuir has written, alone or with his collaborators, since 1906. With few exceptions, all are first communications of the results of original research and deal with what has come to be known as 'fundamental' science. As the creator of the subject of surface chemistry, Dr. Langmuir was awarded a Nobel Prize in 1932, and men of science the world over have honoured him. This book, which collects together twenty of his chief papers in their original form and gives a complete bibliography, is a testimony of his eminence.

The bibliography groups the two hundred-odd papers into the following eight sections: general topics, scientific research, philosophy of science, incentives in science and in industry, and scientific education; structure of matter, of molecules, atoms, crystals, proteins, and ferromagnetic materials; conduction, convection and radiation of heat, diffusion, evaporation in vacuum and in gases, and gas-filled incandescent lamps, etc.; mechanism of chemical reactions at high temperatures and low pressures, and catalysis; high-vacuum phenomena, vacuum pumps, electron emission and space-charge effects; electric discharges in gases, especially at low pressures; surface chemistry, adsorption, surface tension, monomolecular films, and biological applications; meteorology and related fields, aviation, oceanography, turbulent motion of water and air, submarine detection by use of the binaural effect, precipitation static and icing of aircraft.

This record, admirable though it be, is not the uniquely remarkable feature of Dr. Langmuir's career. What is surprising is that all this fundamental work was done in an industrial research laboratory. It could not have been done in a British industrial laboratory during these past forty years, and I doubt very much whether it could be now. It would be misleading to argue from this one exceptional case that American industrial research is more imaginative than British and allows greater freedom to its workers. In both countries the industrial laboratory is all too often merely called upon after trouble has occurred and is not encouraged to think up anything new. There are, of course, magnificent exceptions, but the great majority of industrial scientists are concerned with matters only after lack of knowledge of them has caused difficulties. The real truth of the matter is that it is regrettably rare in either country—or elsewhere, for that matter—for a large concern, once having picked a good man, simply to leave him to follow his bent.

"During these first few years", says Dr. Langmuir, "while I was thus having such a good time satisfying my curiosity and publishing scientific papers on chemical reactions at low pressures, I frequently wondered whether it was fair that I should spend my whole time in an industrial organization on such purely scientific work, for I confess I didn't see what applications could be made of it, nor did I even have any applications in mind. Several times I talked the matter over with Dr. Whitney, saying that I could not tell where this work was going to lead us. He replied that it was not necessary, as far as he was concerned, that it should lead anywhere". This was during 1909–12. Not the least interesting parts of the book are those in which Dr. Langmuir describes how he came to do a classical piece of research and what applications eventually sprang from it. The General Electric Co. of America has presumably had no reason to regret its broad-minded and open-handed attitude.

There is still, and not only in Great Britain, an insufficient appreciation of the importance of the genuine discoverer within industry. It is generally felt in Britain that fundamental research can be left to the universities—indeed, many firms back their faith in them with substantial and conditionless money payments. It is not so much nowadays that industrialists do not believe in fundamental science but that they elevate it beyond their reach. While university 'dons' are treated with exaggerated respect as high priests to be propitiated and occasionally consulted, their own scientific employees are kept in their proper subordinate place. I think the fact of the matter is that the traditional British business man is rather frightened of science; he knows now (rather belatedly) that he has to have it, but the way he intends to get it is very often like this. It would never do to have a man pursuing truth for truth's sake on the firm's own premises—it would unsettle everyone and make things difficult to run. Genius is always an awkward bedfellow.

If one adopts a conservative attitude, this is a perfectly reasonable point of view. The man of science is paid to improve the products, to increase production and lower costs—nothing more. If anything a little more fancy is needed, one can always consult a university professor.

But this is not the way that whole new industries are built, nor, fortunately, is it the universal custom. The more progressive and less traditional the industry, the more intelligent the way in which scientific workers are used within it. One cannot help feeling, however, that we have still to discover the technique of carrying on pure research side by side with the development and application (if any) of its fundamental discoveries. Science is universal, and it is stupid to separate one aspect from another.

In that spring of the post-war world, when men optimistically planned the future, it was indeed often enough said that scientific research was vital to the nation's progress. Later, the dismal pressure of events led, as usual, to a more hard-headed appraisal. What is needed, we are now told, is the translation into industrial practice of already known results. While there can be no doubt that our immediate problems of production should be viewed in this light, it would be a disaster if, thereby, there occurred a reaction against research proper in the industrial field. The future greatness of Great Britain will not lie in a mere routine application of established scientific fact. This is the lesson to be learnt from Dr. Langmuir's book.

D. P. Riley

COMPANY HISTORY IN THE AMERICAN CHEMICAL INDUSTRY

American Chemical Industry
Edited by Williams Haynes. Vol. 6: The Chemical Companies. Pp. viii+559. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1949.) 10 dollars; 75*s.* net.

ALTHOUGH it is not a common practice in publications comprising a number of volumes to preface each volume in such a way that the reader may know the number of volumes to expect and may visualize the broad plan of the work, this has been done to advantage in a number of such publications, and it is a great pity that Mr. Haynes did not so preface this or any other volume of his series of six books on the "American Chemical Industry". It is learned that Vols. 2, 3, 4 and 6 have been published so far, but not Vols. 1 and 5, although Vol. 5 is promised for the early future.

Vol. 6 consists of the histories of 219 American chemical-manufacturing corporations that have been edited "not to uniformity, but to strictly factual, almost encyclopedic form". For this reason alone, the volume is not one to be kept on the book-shelf for occasional light reading; but, as a book of reference for information about the principal members of the industry, it has a fund of detail. The information should be completely reliable, as the histories have been written by the companies themselves and have only been edited with the object of rationalizing length, style and content.

Naturally, in these modern times of rapid development, of newly formed companies and of amalgamations and mergers, the reader with a taste for history is more interested in the older companies that have developed, under the direction of individual enthusiasts, from small drug-stores or from back-garden factories to large business concerns still bearing the names of their founders. It is interesting to dissect the 219 companies described in this volume and to discover that two-thirds of them were founded only during the past fifty years, that 28 per cent originated during the period 1850–1900 and that only 7 per cent came into existence before 1850.

These figures are not exact because some companies, founded in one period, may have roots in a much earlier period under a different name and possibly in a different country. For example, Arnold Hoffman and Co., Inc., holds the longest record of continuous service in the textile industry, but only under this name since 1900, whereas the founders, Benjamin and Charles Dyer, started their small wholesale drug store in 1815. Another well-known firm, Merck and Co., Inc., and its predecessor companies originated in 1818, but the business in the United States under the name Merck only dates back to 1891. The origin of the firm of E. Merck, however, was the seventeenth-century pharmacy "At the Sign of the Angel" in Darmstadt in 1668, which business has remained in the Merck family for more than 280 years. The famous du Pont company, associated with explosives for many years, started shakily in 1802, heavily in debt and with explosions destroying part of the mills, but by 1945 its 61,000 employees had produced the stupendous total of 4,500 million lb. of military explosives for the Second World War. Colgate–Palmolive–Peet Co. can be traced back to Colgate and Co., manufacturers of soap and candles in 1806. Devoe and Reynolds Co., Inc., is sixth on the list of the oldest American business firms in continuous operation since their inception, being the outgrowth of a small New York business in paints and oils established in 1754.

However, this is only selecting a few of the older and therefore the more interesting company histories. The others, not so old but none the less interesting, are here to see, recorded in strict alphabetical order and fortified by two full indexes of names and products respectively.

PROBABILITY

The Theory of Probability
An Inquiry into the Logical and Mathematical Foundations of the Calculus of Probability. By Prof. Hans Reichenbach. English translation by Ernest H. Hutten and Maria Reichenbach. Second edition. Pp. xvi+492. (Berkeley and Los Angeles: California University Press; London: Cambridge University Press, 1949.) 12.50 dollars.

THE German edition of this book has had a considerable reputation; substantial revision has been done for the translation. It begins with an elementary account of symbolic logic and a discussion of the axioms of probability theory; the meaning of the subject-matter occupies most of the rest of the book. Probability is defined in terms of the Venn-Mises limiting frequency. The first problem is to show that this satisfies the axioms, and it is to the author's credit that he recognizes that this is desirable. He does it, but does not appear to see the magnitude of the price that he has to pay. It is well known that even for a random series the limit cannot be proved either mathematically or experimentally to exist; and the author does not assume its universal existence. He finds then that, to prove either of the addition and product rules, it is necessary to assume two limits of this type to exist. Thus, any development of the theory must rest on a complicated substratum of existence postulates, which are asserted for the cases considered but not as always true; hence, in any specific application it could be objected that at least one of the limits concerned may not exist and that consequently nothing relevant to that application has been proved.

The author ridicules the alternative that probability is a primitive idea representing a degree of rational belief and exists as a relation between any pair of propositions. His argument against it, when stripped of rhetoric, seems to reduce to "A lot of beliefs are irrational; therefore there can be no theory of rational belief". He does, however, investigate seriously a "many-valued logic", which appears to be the same thing. The general postulate does guarantee that any hypothesis can be tested by means of the theory when relevant data arise; Prof. Reichenbach's caveats serve only to restrict the scope of scientific method without even specifying the cases where it is not applicable.

The principle of inverse probability is proved subject to the restrictions made by the author—the prior probability is required to be based on previous knowledge, as in some statements in Karl Pearson's papers—but he fails to see that this would imply an infinite regress (cf. Bertrand Russell's

"Human Knowledge"). He makes the usual onslaught of advocates of frequency theories on the "principle of indifference", the function of which was to state ignorance and give the applications a possible starting point. He even states that no modification that would meet one of his difficulties has ever been suggested—in fact, I gave one in 1931, and modifications for other cases have been suggested at various times since 1919.

The book is difficult to read; for example, "theorem" and "axiom" appear to be treated as synonymous on p. 58, and there are far too many forward references. However, some of the comments are very apt. To some extent they overlap those in Bertrand Russell's "Human Knowledge", on which I comment in a forthcoming paper in *Mind.*

There is abundant work to be done in probability theory, and philosophers can make and have made important contributions. However, these contributions will be better when more philosophers find time to attend to constructive developments in the rational belief theory within the past thirty years.

HAROLD JEFFREYS

THE PLANNING OF CAMBRIDGE

Cambridge Planning Proposals

A Report to the Town and Country Planning Committee of the Cambridgeshire County Council. By Prof. William Holford and H. Myles Wright. Vol. 1: Pp. xvi+102+9 plates. Vol. 2: Maps and Drawings. Pp. viii+58. (Cambridge: At the University Press, 1950.) 30*s*. net.

CAN Cambridge control its own destiny in the face of a multitude of unplanned events which may affect its shape, size and appearance in the coming years? This is the question posed by Prof. W. Holford and Mr. H. Myles Wright in the proposals placed by them before the Cambridgeshire County Council; this body has in its turn to submit next year to the Minister of Town and Country Planning a development plan for Cambridgeshire. The planning of Cambridge, a unique university and market town, is a matter of national interest, and the University, Borough and County are all closely concerned in finding the right solution.

The determining factor in the proposed plan is that the growth of the population of Cambridge should be controlled, the future population not being allowed greatly to exceed the present figure. It is to be hoped that this will meet with no serious opposition. The second feature in the plan is that the centre of the town shall be left essentially unchanged, and that relief from the rapidly growing traffic problem should be found in a scheme of by-pass roads in the outskirts and relief roads in the centre.

One important problem is to induce traffic to keep clear so far as possible of what the authors call the "spine road"—that which starts in the south as Hills Road and ends in the north as Huntingdon Road, changing its name seven times on its way through the town. A relief road from the Histon Road corner at the top of Castle Hill, running nearly parallel to the spine on the east side and rejoining it at the corner of Emmanuel Road, is projected; this road has two unfortunate features which the authors have found it impossible to avoid. It involves calling upon Jesus College to sacrifice private land and amenities, and it crosses Christ's Pieces. The second relief road is on the west side of the spine, continuing a widened Guildhall Street through to the end of Downing Street opposite Emmanuel College; this scheme includes a large car park, which is badly needed. When these streets are completed, it is proposed that the present bridge over the River Cam by Magdalene College shall be closed to vehicular traffic—a further incentive to traffic to avoid using the spine road, even in part, for through movement. These two new roads, with a somewhat elaborate system of traffic circulation by one-way roads, should take care of the more serious traffic problems in the town centre.

Next comes the scheme for keeping heavy through-traffic out of the central portion of the town. An outer ring has two by-pass roads: that to the east leaves the road to Royston, A10, beyond Trumpington and crosses the Cam by a new bridge at Chesterton, swinging round north of the town to join the St. Neot's Road west of Madingley Wood; the other, shorter by-pass road on the west side, proceeds via Grantchester and Coton to the Madingley Road at the foot of Madingley Hill. Parts of these outer by-pass roads belong to a long-term programme. An inner ring road is also projected, of which the western route runs along Chaucer Road, crossing the Cam by a new bridge on to Barton Road, thence northward to Madingley Road, which it crosses just east of the Observatory and on to Huntingdon Road. This road is designed to free the Backs of through-traffic from the Huntingdon Road to the south. One very serious criticism must be made of this plan, and that is the choice of the point where the road crosses Madingley Road.

The public-spirited action of St. John's College, the late Prof. Newall and Trinity College has kept the Observatory clear of buildings on its eastern and southern sides. This new scheme proposes a trunk route, presumably taking heavy traffic with blazing headlights at night, approaching the Observatory directly from the south and passing close to the Observatory grounds on the east side. If the Observatory is to continue to function properly, this inner ring road must be diverted to another crossing point, preferably on the west side of the University Farm. Very little farther distance would be involved for the traffic, and the need to move the Observatory farther away from Cambridge would be avoided. Care should be taken to dislocate as little as possible the experimental work of the University Farm. The very heavy expense involved in moving the Observatory would be obviated. It can be said that in all innocence the planners have selected the very worst point for crossing the Madingley Road with their inner ring road. It will ultimately involve the University in the maximum expense and dislocation of scientific work. It is not too late yet to alter the lay-out of this road and to modify plans for new University buildings not yet erected.

Other points of interest in the general scheme are to be found in the provision of access to the railway station from the east side (though no change is contemplated in its unique platform arrangements) and in the regulation of extensions of building with a refusal to allow further ribbon development and extension to the west. The two attractive volumes containing the proposals bear throughout the hall-mark of the Cambridge University Press, and the fifty-eight maps that illustrate the proposals are enlightening and convincing.

F. J. M. STRATTON

MECHANICS OF THE CONTRACTILE ELEMENT OF MUSCLE*

By PROF. A. V. HILL, C.H., F.R.S.

The Parallel Elastic Component

THIS paper deals with the contractile component of muscle, the part which, when stimulated, can shorten and do mechanical work, or develop a force if prevented from shortening. We shall consider chiefly the properties of skeletal muscle, the striated voluntary muscle of vertebrates. In such muscles, as they occur anatomically in the body, the contractile component is mixed with inert elastic material the presence of which makes the experimental study of the mechanical properties of the contractile element itself more difficult. The contractile units, the striated muscle fibres, are surrounded by a sarcolemma which is strong and elastic and provides most of the resistance to static stretch. At the ends of the fibres are elastic tendons which fuse into bundles and join the muscle to the skeleton. The sarcolemma is in parallel with the contractile material, the tendons in series with it. In the muscle as a whole there is further elastic material in parallel with the fibres. In smooth muscle an almost infinite variety occurs in the distribution of elastic material. At one extreme, for example, in the retractor of the pharynx of the snail or the muscle of the body-wall of Holothuria, a parallel elastic component is almost completely lacking: at rest quite a small load will gradually draw the muscle out to great lengths. At the other extreme, the muscular component of the wall of such hollow organs as blood vessels, the urinary bladder, or bronchi is so intermixed with inert material that its mechanical properties are difficult to evaluate. Some smooth muscles, such as the retractor penis of the dog or the nictitating membrane of the cat, are very similar in their elastic properties to striated muscle.

In order to study the mechanical behaviour of the contractile material proper, at rest or during activity, the complication provided by the parallel elastic material must be avoided. This can be done by employing muscles, such as the snail retractor, in which the parallel elastic component is of negligible importance; but that greatly limits the choice of material and the range of investigation. A better and more general method is to work within the range of lengths in which the force exerted by the parallel elastic component is insignificant. In skeletal muscles with long parallel fibres, for example, the sartorius of frog or toad, or particularly the iliofibularis of tortoise, this range is ample. Within this range the tension at rest is small, and depends on the muscle's previous history of stretch and stimulation. At greater lengths the mechanical properties of the resting skeletal muscle, for example, its load-extension curve and its thermo-elastic relations, are due chiefly to the parallel elastic component. Much research has been devoted to these properties of resting muscle, but its results tell us little about the contractile component itself, and nothing about its active state; such work could better be done on inert connective tissue.

It is fortunate that the range of lengths within which the tension of the resting skeletal muscle is small is physiologically the most interesting (see graph, p. 417). It includes the length at which the greatest contractile force can be exerted, and all the lengths which can occur in the living body. With due precautions, therefore, the effect of the parallel elastic component can be largely avoided.

The Contractile Component at Rest

Of the contractile material itself, the properties at rest can best be described as follows, without any reference to elasticity. A skeletal muscle with long straight fibres, under zero load, can be brought by one or two shocks to a very short length, and there it remains. That its fibres really are short, not merely lying in folds, is shown by two facts: (i) the latent period, that is, the interval between a stimulus and the first sign of contraction, is much the same as at greater lengths; if the fibres, or fibrils, were in folds they would have to take up their slack before being able to exert an external force, and that would greatly increase the latent period; and (ii) if a quick stretch be applied to the shortened muscle it immediately resists, the tension rising rapidly from the start; if there were slack, delay would be evident before the tension began to rise. Now with the shortened muscle attached to a delicate tension recorder, let us gently stretch it, say, 1 or 2 mm. During the stretch its tension rises—more the faster the stretch. As soon as the stretch ends, the tension begins to relax; but not to zero—the final value is small but measurable. Let us stretch it again the same distance. Once more the tension rises, to fall again after the stretch to a small but measurable value. The process can be repeated until at greater lengths the elastic resistance of the parallel elastic component, as its elements become taut, begins to obscure the effect, each successive increment of length then leading to a greater increment of tension from which little relaxation occurs.

If a muscle, shortened by stimulation and then stretched, be released to a length at which it previously showed measurable tension, its tension is now found to be less. The tension at any length depends on the previous history of stimulus, stretch and release. The tension is greatest at any length when the muscle has been stimulated previously at some shorter length and then pulled out, and least when stretched to some greater length and then released. The whole process of stimulus, shortening, stretch and release is repeatable, no permanent change in the muscle being detected. One can think of stimulation as causing a general release, a shaking up, of the molecules or elementary units of the structure, which proceed in relaxation to 'set' in a pattern or distribution appropriate to the final length attained. There they stay, weakly held together by structural forces, until an external force disturbs them.

In a smooth muscle at rest, the tension resisting rapid stretch may be large and easily measured. Directly the stretch ends the tension begins to drop, and Bozler found in the snail's retractor that its rate of fall was the same as during relaxation after an isometric contraction. In most striated muscles at rest the resistance to stretch is rather small, though in some, notably those of the tortoise, it is much greater. When the stretch ends, the tension rapidly falls, but at quite a different rate from the fall of tension after contraction. Indeed, a striking difference exists in the fact that the rate of fall after contraction is greatly affected by temperature, but after stretch practically not at all. Can Bozler's result be true only at the particular temperature he used ?

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* Introduction to a discussion on muscle, on July 28, during an International Colloquium on Rheological Problems in Biology held at Lund.

In certain smooth muscles at rest, those unsupported by a parallel elastic component, the contractile material seems to be almost indefinitely plastic and extensible, even under a very small load. A quick stretch is met by a strong resistance, a slow stretch by a small one. In such muscles, apparently, no static tension at rest is possible at any length. In striated muscle, on the other hand, a small but finite tension can be detected down to quite short lengths if the muscle is brought to them by the procedure mentioned earlier. It seems most likely that this small tension is exerted by the contractile component itself, not by the parallel elastic structures ; for it is reduced by a stretch followed by an equal release, and remains reduced until the muscle is stimulated again. In any event, the force exerted by the contractile component at rest is small, not more than 1 per cent or so of that during full activity.

The Contractile Component during Activity

When a muscle fibre is excited by a nerve impulse, or an electric shock, a wave of excitation travels along its surface, as the result of which the interior of the fibre passes temporarily into contraction. When this wave arrives at any point on the surface, it sets up there a change of some kind which travels inwards across the fibre, producing the active state. The physical nature of the wave of excitation, which is always associated with a propagated electric change, need not concern us now : it is presumably the same in muscle as in nerve. The nature of the process by which the contractile state is transmitted inwards from the excited surface is not known ; but the time required for the fibre to become fully active is far too short for diffusion of a substance inwards from the surface to be the cause ; an event, not a substance, is propagated to the inside, setting in train as it goes the complex sequence of events recognized as contraction.

The unit of muscular activity is the single twitch, produced in response to a nerve impulse or an electric shock. The ordinary picture of a muscle twitch shows a gradual rising phase, a blunt maximum and gradual relaxation. By repeating the stimulus at a sufficient frequency, the resulting twitches can be fused into an apparently smooth maintained contraction, which begins to decline soon after the last stimulus. The gradualness of the development of tension in an ordinary 'isometric' contraction gives an entirely misleading picture of the rapidity of onset of the active state. The form of the isometric myogram is determined by the rate at which the contractile component can shorten against the increasing tension of the elastic component in series with it as that component is stretched. We have to use special devices to avoid this complication. When we do so, the following properties of the contractile material during activity emerge.

(1) The velocity of shortening against a load is greater the smaller the load. The experimental relation between speed and load can be expressed by a family of curves, each for a given length. Over a considerable range of lengths, however, it is given mathematically by the single characteristic equation :

$$(P + a)\, v = b\, (P_0 - P),$$

where P is load, v is velocity of shortening, P_0 is the maximum force which the muscle can exert (at zero speed), and a and b are constants. In most muscles a/P_0 is about $\frac{1}{4}$, so that the maximum speed of shortening (under zero load) is about $4b$. We shall consider this relation again later ; it represents the most significant mechanical property of active muscle. It is important to note that P need not be constant ; it can vary with time or distance during contraction. The velocity of shortening depends on the load at the moment, and varies instantly as the load varies.

(2) After a stimulus a finite interval elapses before contraction occurs. This is known as the latent period, and the term will be used with its common meaning to cover the time before the first sign of increased tension or shortening appears. By two special methods, however, it can be shown that mechanical changes begin much earlier than this : (*a*) if a rapid stretch is applied during the earlier part of the latent period, the muscle begins to resist stretch from about the middle of the latent period onwards ; by the end of the latent period it is resisting strongly ; (*b*) by an extremely delicate method employing a piezo-electric crystal and high amplification, it can be shown, in a muscle under initial tension, that the first sign of activity is a slight lengthening, beginning at about the middle of the latent period. This is gradually reversed and merges into the positive phase at the end of the latent period as ordinarily observed. This 'latency relaxation', so called, is not found in muscles under low initial tension. It is not due to an initial increase of extensibility, for the method of quick stretch always shows a decrease of extensibility starting at about the same moment. It is probably due to a slight increase of length, an accompaniment of the extensive molecular change underlying the observed increase of rigidity.

There are two other early signs of the onset of the active state : (i) the heat production begins at its maximum rate at about the middle of the latent period ; and (ii) an increase of optical transparency begins at about the same moment.

(3) By the method of rapid stretches it is found that full activity has been developed much earlier than ordinarily supposed. By an appropriate stretch applied during the earliest phase of contraction, a muscle is caused to develop almost abruptly a force considerably greater than the maximum of an ordinary isometric twitch, indeed, about equal to the force of a maintained tetanic contraction. This force is held for a time and then gradually decreases as relaxation sets in. The explanation is simple. The force in an ordinary isometric contraction can be developed only by the contractile component shortening and stretching the elastic component in series with it. This shortening goes on slower and slower as the tension rises, and relaxation has really begun long before this shortening is complete. The maximum tension of an ordinary isometric twitch is reached as a balance between internal shortening and oncoming relaxation. A rapid stretch obviates the necessity of the slow shortening and finds the muscle already in its fully active state.

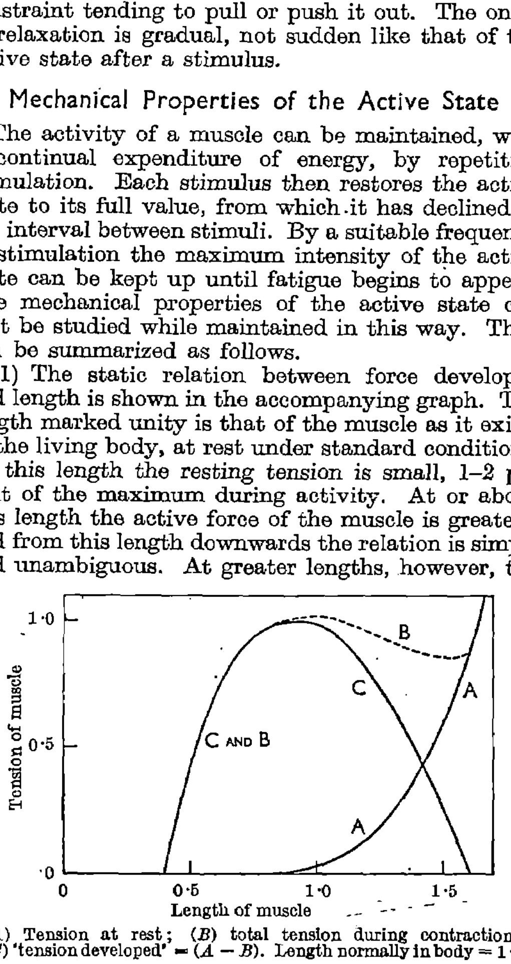
It is difficult to say how rapid the onset of full activity really is. The fibres of a muscle vary largely in size, and their mechanical characteristics may also vary. The maximum force could not be developed until the slowest fibres were fully active. Moreover, it may take time for activity to spread throughout the body of a fibre, from the surface at which excitation occurs. It is certain, however, that a muscle can resist stretch with its full tension within about 10 per cent of the time normally required to reach the maximum tension of an ordinary twitch.

(4) After contraction occurs relaxation, in which the original mechanical state is restored. In a contraction under constant load, the muscle shortens and then lengthens again; in a contraction at constant length, the tension rises and then falls. It has long been disputed whether relaxation is an active or a passive process, but the evidence is now decisively in favour of the latter. For example, no heat is given out in relaxation; any that appears is due to mechanical energy converted into heat as the load falls or the elastic elements shorten. Again, as we have seen already, when a muscle with straight fibres is stimulated and allowed to shorten freely, it remains short afterwards, under a slight but measurable tension, with the usual latent period and an immediate resistance to a quick stretch. Moreover, a muscle suddenly released during relaxation does not redevelop its tension; it has become inert. It appears, therefore, that relaxation does not involve anything more than the disappearance of the active state set up by stimulation. Lengthening does not occur unless there is a load on the muscle to stretch it, or unless it is subject when shortened to elastic constraint tending to pull or push it out. The onset of relaxation is gradual, not sudden like that of the active state after a stimulus.

Mechanical Properties of the Active State

The activity of a muscle can be maintained, with a continual expenditure of energy, by repetitive stimulation. Each stimulus then restores the active state to its full value, from which it has declined in the interval between stimuli. By a suitable frequency of stimulation the maximum intensity of the active state can be kept up until fatigue begins to appear. The mechanical properties of the active state can best be studied while maintained in this way. They can be summarized as follows.

(1) The static relation between force developed and length is shown in the accompanying graph. The length marked unity is that of the muscle as it exists in the living body, at rest under standard conditions. At this length the resting tension is small, 1–2 per cent of the maximum during activity. At or about this length the active force of the muscle is greatest, and from this length downwards the relation is simple and unambiguous. At greater lengths, however, the tension exerted at rest provides an increasing complication. Can we simply subtract the tension at rest from the total tension exerted during activity, to obtain the contribution of the active contractile component? We can under two conditions: (*a*) if the parallel elastic component be supposed to take the whole, or nearly enough the whole, of the resting tension; and (*b*) if it be assumed to run the whole length of the muscle, in parallel with the system made up of the contractile component with its elastic body in series with it. The former condition seems very likely; it is doubtful whether the contractile component at rest exerts, at any length, more than a small tension. The second condition is less certain. In a single fibre, for which the clearest results have been obtained, the parallel elastic component consists of the sarcolemma alone, which is in parallel with the contractile component itself but not with its tendinous ends. Even if the recording system had no significant extension of its own, the extra tension developed during activity must stretch the tendons and so allow the sarcolemma to shorten. But the load-extension curve of the resting fibre, presumed to be that of the sarcolemma, rises very steeply at greater extensions, so that even a small shortening of it, as the tendons are stretched, is bound to cause a certain fall of the passive term in the tension. Thus the extra tension developed by the contractile component during activity exceeds the difference (total tension – resting tension) by some unknown amount, possibly not large, but probably not negligible.



(*A*) Tension at rest; (*B*) total tension during contraction; (*C*) 'tension developed' = (*A* – *B*). Length normally in body = 1·0

In spite, however, of this uncertainty, the observed form of the relation in the graph probably gives a general impression of the facts not too far from the truth. If so, a little reflexion shows how peculiar a relation it is. Try to imagine an elastic body which exerts a maximum force at one special length, the force diminishing more or less symmetrically on both sides and becoming zero at about 0·4 and 1·6 times that length! This is one of many reasons for not regarding the contractile component of the active muscle as an elastic body. One could devise a system of attractions and repulsions possessing this property, but to locate them in an actomyosin thread might tax one's ingenuity.

(2) The dynamic properties referred to earlier as the characteristic relation between load and velocity are common to all kinds of muscle. Whether the characteristic equation itself applies, with sufficient accuracy to make it useful, to any muscles other than the skeletal muscles of frog, toad and man has not yet been established, but a relation of the general type certainly exists. It was natural to suppose—and for many years it was supposed—that this characteristic relation is determined by the viscosity of the contractile material. The active state was distinguished not only by the power of shortening, or of developing a force, but also by an increase of viscosity, large or small, depending on the muscle and its temperature. The higher the intrinsic speed of the muscle, the lower the viscosity. There was a minor difficulty, in the fact that according to the viscosity theory the relation between load and velocity should be linear, which it was not; but in a system as complex as a muscle, this difficulty need not be insuperable.

A much greater difficulty was that, when a muscle shortened, an extra quantity of heat was liberated which was exactly proportional to the distance shortened, but independent of the speed of shortening; a viscous resistance to shortening could not provide this relation. If there were really an internal opposition to shortening it had to be constant, like ordinary friction, not increasing with speed like a viscous resistance. Moreover, the amount of mechanical work done in lifting an external load, which could be varied at will by varying the load, had no effect on the heat, provided that the amount of shortening was kept the same. The work plus heat was not constant, as it should have been if a certain amount of potential energy was liberated by the stimulus and then used in overcoming resistance, external and internal. Next, it was found that if a muscle was stretched during an active contraction, a considerable part (under some conditions, the whole) of the work done in stretching it disappeared—that is, it could not be traced afterwards either as heat or as mechanical potential energy. Presumably this work was used up in causing some chemical reaction to go backwards, which in normal circumstances during shortening provided work and heat. No system which included an internal resistance, frictional or viscous, to change of shape could show such relations. The viscous-elastic theory of the active muscle had served its purpose for a long time, it had provoked a variety of new and valuable experiments, but now it must be allowed to die an honourable death.

It is not possible as yet to propose a convincing theory in its place. A striking fact is that the constant a in the characteristic equation between load and speed

$$(P + a)\, v = (P_0 - P)\, b$$

is the same as the constant a of the shortening heat ax, where x is the amount of shortening. This equality, observed in a variety of circumstances, cannot be simply a coincidence. In the characteristic equation, Pv is the rate of doing mechanical work and av is the rate of liberating heat of shortening. Their sum $(P+a)$ multiplied by v—the rate at which energy is set free—is a linear function of the load P. What this simple relation means is not clear, but it is surely pertinent in any theory of the energetics of muscular shortening. The physical framework responsible for the dynamic properties of active muscle must clearly be regarded as coupled mechanically with reversible chemical processes by which energy is supplied in shortening, or absorbed in lengthening. The rate of energy supply is controlled by the tension of the muscle itself. Mechanical coupling of this kind to a source of chemical energy is not so common a property of physico-chemical systems that likely analogies are easily drawn. Its presence in muscle introduces a factor in rheology of which no other example comes to mind.

Structural Pattern of Muscle

It seems pretty clear that the sudden transformation of a resting muscle to its active state must involve a rather fundamental change in the physical configuration of its constituent proteins. The rapid decrease of extensibility following stimulation, and the accompanying ability to shorten and do mechanical work, might imply an extensive alteration in the distribution of electric charge, or of dielectric constant. The examination of such possibilities should not be beyond the power of modern electrical technique. Again, X-ray diffraction methods might throw considerable light on the problem, if equipment powerful enough were available. Optical methods (for example, the comparison of double refraction, scattering or absorption in resting and active muscle, or during shortening and lengthening) might turn up unexpected clues. Possibly also the application of these or other methods to a variety of muscles in a wider range of animals might shed fresh light. Chemical methods are not likely to yield direct results, being too slow and insensitive to follow the rapid transformations that occur during a single contraction; and by repeating the stimulus many times, in order to get measurable quantities, all the processes are jumbled together and their finer details obscured. The contribution which biochemistry can make to the problem is more likely to come from studies of the substances and enzymes that can be isolated from muscle, and an attempt from these to synthesize a working model.

According to the characteristic relation between load and velocity of shortening, the velocity becomes very small as the load approaches the maximum force which the muscle can exert. With loads greater than this we should expect the muscle to lengthen, and so it does. The equation predicts that even under loads considerably in excess of the isometric tension the velocity of lengthening should be small: for example, with $P = 2P_0$, the calculated value of v (assuming $a/P_0 = \frac{1}{4}$) is only one-ninth of the maximum velocity of shortening under zero load. With loads not much in excess of the isometric tension, the velocity of lengthening is actually substantially less than that predicted. With greater loads, however, a different phenomenon appears, the muscle seeming to 'give' or 'slip', just like a wire stressed beyond its elastic limit, or a nylon or polythene thread during 'cold-drawing'. This 'give' or 'slip', however, does not damage the muscle; no permanent effect is produced; as soon as the excessive load is removed, the contraction continues in the normal way.

The same property of active contracting muscle can be exhibited by stretching it at a constant velocity and recording the tension developed. At a very low speed of stretch the tension rises moderately, continuing to rise as the stretch continues; at a higher speed the tension goes higher; it starts to return very abruptly at the end of the stretch. There is, however, a limit to the force with which stretch is resisted: it does not increase indefinitely with speed. Qualitatively, the phenomenon is similar to that observed in stretching a resting muscle, but with much greater forces involved. Direct measurement shows that most of the work done in stretching at high speed appears as heat in the muscle: but the muscle is not altered in the process.

Strength of the Molecular Architecture

We saw earlier why the viscous-elastic theory of the active state of muscle has had to be abandoned. It does not follow, however, that viscous resistance to change of shape is not an important factor in many of the processes described. I doubt whether it is simple viscosity in the classical sense, but many things described as viscous really depend on resistance to change in an organised system, not purely in a random medium. A crystal, without any alteration in the internal pattern of its atoms, can exist in widely different external forms; in passing from one external shape to another, its atoms would have to be largely redistributed in relation to one another. If the process were carried out slowly enough, it need involve no significant change of energy; carried out rapidly, it would in practice require a large expenditure of work. No doubt can exist that in muscle, as in other living structures, a characteristic molecular pattern is present. It is revealed by X-ray diffraction, by birefringence and by other optical effects. If this basic pattern is the same at different lengths, then a rapid change of length imposed forcibly on the system from outside must momentarily break up the pattern, which later re-forms when left to itself. If records of X-ray diffraction could be made rapidly enough, it would be interesting to see whether the pattern alters or disappears while the length is actually changing, to reappear later. Analogous observations might be made with birefringence.

The forces maintaining this molecular architecture in resting striated muscle seem not to be large: quite small external forces can overcome them if time be allowed. A change of external shape provokes an internal resistance, increasing—but only up to a certain limit—with the velocity of change. Pure viscosity could provide no such limit. In the molecular architecture the structural forces might well be different from point to point. A small external force might overcome the individual internal forces one by one, and the change of shape would be slow. A larger external force would overcome the internal forces at a higher level, and therefore more frequently, and the change of shape would be faster. With a rapid change of shape the external force would have to be great enough to overcome the internal forces at their upper limit; however rapid the change of shape, this would provide the limiting resistance.

Some smooth muscles at rest increase indefinitely in length, though very slowly, even under a very small external load. The lower limit of the structural forces in their molecular architecture is apparently very small. The strong resistance, however, to more rapid stretch shows that their mean value is quite high. Can we extend this idea to explain the phenomena of tonus, often described but never assimilated to the other properties of muscle? Let us imagine that the lower limit of these structural forces, holding the molecular architecture together, can be raised by physical influences or chemical agents. The presence of such influence or agent might, so to speak, lock the structure at some particular length or shape, from which only a large force, or a stimulus of some kind —perhaps an ordinary contraction—could unlock it. Many speculations of that kind have been published from time to time, over many years. They spring naturally to the mind of anyone acquainted with the comparative physiology of muscle. The difficulty has been to give them some kind of physical or chemical basis, to tie them on in some way to other properties of muscle. The natural tendency, since they could not be fitted in, has been to disregard the phenomena of tonic-maintained contraction. When not disregarded, tonus has generally been explained as the tetanic response of an extremely slow muscle—as it probably often is. But there are muscles in which a strong prolonged contraction can be broken up quickly by a stimulus—which is not what happens to a tetanus. Something still is missing: but what? Can this idea of a molecular architecture of variable, or adjustable, strength bring all the facts into one picture?

These may be wild speculations, but at least they started off from real properties of real muscles, and perhaps they give some hope of fitting all the properties of muscle into a single intelligible scheme. A cynic once remarked that the only thing that mankind can do is to move things. It would be pleasant to be able to add that at any rate he can understand how, if not why, he moves them.

THE INTERNATIONAL BOTANICAL CONGRESS AT STOCKHOLM

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THE seventh International Botanical Congress was held at Stockholm during July 12–20. The first of the present series was at Paris in 1900, and it was then decided that future congresses should be held quinquennially. The projected fourth congress to be held in London in 1915 never took place: no international congress was possible at that time, and British botanists, influenced by an excess of courtesy or caution, later decided that London should give up its claims, and arranged an Imperial Botanical Conference in 1924. American botanists, having obtained general approval, stepped into the breach and held a Plant Sciences Congress at Ithaca in 1926. This was very successful, and, though it was not rightly one of the series, its far-reaching effects led to its being included. The detailed preparations for the seventh congress, which was to have been held at Stockholm in 1940, were well under way when war again intervened. It gave general satisfaction when the Swedish botanists proposed to carry on with preparations for a congress in 1950; without their sacrifice of time and energy there would have been great difficulties, some obvious, some recondite, which would have needed much consultation and compromise to resolve. It was high time that botanists of all nations met, and the material success of the recent Congress was due to the realization of this; but it should not be overlooked that the splendid opportunity was the result of the determination of Swedish botanists to do whatever was possible to achieve it. To read the list of names of the Swedes who were directly concerned in the preparations makes one realize that practically every Swedish botanist must have had the conference well in mind for the past two years or so.

The first plenary session was held in the magnificent concert hall, H.R.H. the Crown Prince of Sweden, patron of the Congress, making the opening speech. He is known in Sweden as a keen amateur botanist, horticulturist and archæologist, and his remarks had a personal touch, particularly when he commented upon specialization untempered by a wide outlook. Prof. C. Skottsberg, president of the Congress, in his address said that "never before did a country with a population so small as that of Sweden act as host to an international conference equal in size and scope to this botanical congress. Our membership figures, well over 1,450, and distributed among fifty countries, leave all former ones behind". After commenting on the years of devastation and the difficulties of free international scientific co-operation, he spoke of the timidity which had been felt by the Swedes when they decided to renew their efforts to bring botanists together. "Our Congress is international. All countries were asked to join". Several countries were not able to join because of financial stringencies; but a small number of delegates were financed by Unesco. "Another matter of concern is that there were, in other countries, distinguished botanists who wanted to come and who *could* have come, but were prevented from coming by a political system which believes in self-sufficient isolation as the proper road to progress. For this reason, several old friends and colleagues who were among the first to apply for membership have been obliged to withdraw their applications. It is gratifying that the Soviet Union has found it possible to send a delegation. Unfortunately, the official announcement with the names of the delegates and the titles of their papers reached us so late that the Congress Programme was in the press".

The effect on botanical science of the War in several countries was commented on, and the president mentioned incidentally that "the British delegation, including men and women from all the Dominions and some of the Colonies beyond the seas, is the largest of all".

Most of the speech was in English; but parts were in French, German and Spanish, doubtless a surprise to those younger botanists who had had no previous experience of the linguistic abilities of Scandinavian and 'Benelux' countries.

The session ended with an address by F. T. Wahlen, of the Food and Agriculture Organisation of the United Nations, on "Botany and World Husbandry". It was a clear summary of the relation between botanical science and world energy. The first 'joint inventory' had been made last year at the U.N. Scientific Conference on Conservation and Utilization of Resources. So far as our food reserves are concerned, we are living on a bank account without a balance sheet and with no possibility of assuring the future rate of use. From an overall point of view there can be no doubt that the plant scientist holds the key to the greatest treasure-store humanity possesses: how we make use of the material and ideal riches invested in the plant cover of our planet will be one of the decisive factors in the welfare and happiness of mankind. The problems we have to face call for sound co-operation between all those who study any aspect of plant life.

Doubtless this address was given so important a place in the programme because of its importance in directing the attention of an international gathering of botanists to the wider aspects of their studies. Unfortunately, however, it did not receive the attention which it merited, for members were worried by a nice calculation of the time necessary in Stockholm to obtain lunch and get to the University, where the sectional meetings began at 1 o'clock. The purpose of the lecture would have been much better achieved if it had been arranged for the evening: moreover, with lantern slides it would doubtless have had an appeal to the general public.

The proceedings of the Congress were divided among fifteen sections: Agronomic Botany (president, F. T. Wahlen); Cytology (president, C. D. Darlington); Experimental Ecology (president, W. H. Pearsall); Experimental Taxonomy (president, T. H. Goodspeed); Forest Botany (president, D. V. Baxter); Genetics (president, Ö. Winge); Morphology and Anatomy (president, A. J. Eames); Mycology and Bacteriology (president, J. Ramsbottom); Nomenclature (presidents, E. D. Merrill, T. A. Sprague); Palæobotany (president, H. Hamshaw Thomas); Phytogeography, with Comparative Ecology (president, C. Troll); Phytopathology (president, E. C. Stakman); Plant Physiology (president, F. G. Gregory); Taxonomy: Cryptogams (president, F. E. Fritsch); and Taxonomy: Phanerogams (president, H. J. Lam).

The sectional meetings were held on Wednesday afternoon (July 12), the mornings and afternoons of Friday, Monday, Tuesday and Wednesday, and Thursday morning. The meeting rooms were not too widely dispersed; but it was impossible, even if without responsibilities, to listen to more than an occasional paper in a section other than the one in which individual particular interest was centred. There are proposals to increase the number of sections at future congresses; but this will tend to make matters worse and lead eventually to the splitting off of sections or groups of sections into specialist congresses. It is in the best interest of botanical science that its several parts should remain as closely interwoven in theory and in practice as they are in fact.

Although there were fifteen sections, there was frequent grouping of subjects important to more than one section; indeed, joint meetings of even four sections were not exceptional.

The arranging of the programmes for the several sections must have been very laborious. The original intention was to decide on special subjects and invite selected botanists to contribute. To them an average of thirty minutes was allotted; those who offered papers were allowed fifteen minutes. Some of the former were summaries of modern lines of investigation and were most valuable in bringing forward knowledge of much work carried out on special aspects of botany through the years of intellectual obscurity. Perhaps more latitude was given to the papers which were offered than will be advisable at future meetings, for some of them dealt with results already published. In the present state of intercommunication there is justification in directing attention to work which has apparently been overlooked; but in more normal times it must be assumed that publication has been effective in its purpose. This would scarcely deserve mention except that the practice is not unknown elsewhere, and occasionally has aspects which are not entirely without motive, as well as overcrowding programmes so that comment, valuable criticism and interesting discussion have to be sacrificed to keep rigidly to a time-table.

The general level of communications in the sections was commendably high; but none seems to have been of that originality and eminence that calls for special comment. Everyone seems to have been satisfied with the section in which he was particularly interested; but after much inquiry I was unable to find that other sections differed from that of Mycology and Bacteriology, where the general accounts of special aspects given by invitation to form an introduction to their more detailed consideration were the most stimulating; but many important facts and points of view cropped up with unexpected frequency in the short communications: the occasional non-appearance of an advertised speaker, where there was no written communication, provided much-needed time for discussing these results and getting them in some sort of perspective.

Having regard to the lapse of fifteen years since the last International Botanical Congress, those responsible for arranging the programmes accomplished a very difficult task in a most excellent way. Much of their basic scheme will have to be followed in future congresses if some sort of unity is to be retained. The ground has been cleared, and we should look forward to making the best use of the opportunities international congresses give for the discussion of fundamental problems which have arisen or have been materially influenced by research in the years between the meetings.

No useful purpose would be served by listing the numerous subjects which were discussed, especially as abstracts of all communications are to be published in a few months.

Exception, however, may be made for the Russian communications, as they give some indication of a line of approach to international botanical matters. A demand was made for time for communications, which I understand came so very late that normally it would have been refused. It was in the best interests of international scientific relations that the Swedes decided that an exception should be made; I think the majority of the congress members approved of their decision.

The authors and titles of the communications were: I. E. Glyschenko, "Hybridisation of Plants by Grafting"; K. S. Suchov, "The Directed Influence of Phytopathogenic Vira on Plants"; N. V. Turbin, "New Experiments elucidating the Nature of Fertilization"; V. N. Stoletov, "The Nature of Hybrid Plants"; P. A. Baranov, "Cultivated Plants during Extreme Conditions of Life"; V. N. Soukatchev, "On the Exploration of the Vegetation of the Soviet Union".

Obviously there was great excitement about the first communication, and the hall was crowded. There was a feeling that the meeting was to be used as a platform for something other than a discussion of scientific facts. It is to be regretted that most of those who interrogated Dr. Glyschenko asked questions designed to cause embarrassment, through his ignorance of the minutiæ of experiments which serve to confirm the more generally accepted views, rather than to elicit critical information about the scientific facts upon which the Russian official dogma is based. Nothing was gained by ridicule—except waste of time, for the meeting dragged on until 12.30 a.m.

One point that needs to be stressed is that there should be some standardization of the size of lantern slides. I understand that all who wished for a lantern were asked what size of slide they were bringing. The almost invariable answer was "the usual . . . size". This resulted in the loss of time and probably of temper, when, as happened at the first meeting of one section, five different sizes of slides were produced, which necessitated the use of three different lanterns. A paper given at an international congress, even if it does not require the making of new slides, should be regarded as of such importance as to warrant the demand that they should be of a specified size or sizes.

The official excursions and visits, apart from those arranged for ladies and other 'passive' members, began after Wednesday's opening sectional meetings, when buses were taken to the Royal Palace at Drottningholm, where H.R.H. the Crown Prince, deputizing for H.M. the King, received the guests. Unfortunately, the day was overcast and rather cool, and the full beauty of the "Versailles of Sweden" was not seen, though, as rain kept off, refreshments were served in the open. The famous theatre provided many with a resting place from which they could admire the remarkable stage.

The following day was spent in exploring the Stockholm Archipelago. There was a general trip on a pleasure steamer; but there were several others labelled for specialists, where the transport was by naval minesweepers reached by landing craft. Swedish botanists as a whole have an exceedingly wide knowledge of the constituents of their flora, and the various leaders thoroughly enjoyed discussing problems of distribution, habitat relations and succession of all plant groups.

The second plenary session was on Saturday morning. After the necessary business two interesting addresses were given. Dr. F. Verdoorn first spoke "On the History of International Botanical Congresses" from that of Brussels in 1864, where, as throughout the nineteenth century, horticulture played a prominent part in them, up to and through the present series of purely botanical ones. Dr. F. W. Went then spoke on "The Effects of Climate on Plant Growth and Distribution". This was an account of the work being carried out at the wonderfully designed and equipped laboratory at Pasadena, California, illustrated by colour photographs. Afterwards visits were made to the Forestry Research Institution, the Natural History Museum, and the Bergius Botanic Garden, which are in fairly close proximity to one another, and to the Royal Swedish Academy.

Sunday was spent at Uppsala. A start was made from Stockholm at 9 a.m. and many did not reach it again until 2.30 a.m. There were five parties, with their distinguishing letters, which were supposedly grouped according to particular interests; but some whimsicality seemed occasionally to have intruded itself. However, all were impressed by what they saw of the facilities for research in the several institutions, and the enthusiasm and ability of those engaged in it.

After lunch there was what might be styled a Linnæan pilgrimage. First there was a visit to the old University Botanic Garden, now laid out again as Linnæus arranged it, and his house with many of his possessions. Then a drive to his country estate at Hammarby, which probably never before had so many visitors at one time, with the two eminent Linnean authorities, Prof. R. E. Fries (president-designate of the 1940 Stockholm Conference) and Col. A. Uggla as guides. Finally, many went to the fine old cathedral to see Linnæus's tomb and memorial, which had a small floral tribute at its base tied with ribbons of the national colours. The veneration with which Linnæus is regarded by Swedish botanists was understood and appreciated by many who, until then, had been restricted to a modern text-book outlook. To those who had had the good fortune of a previous visit to Uppsala the blending of the ancient and modern gave renewed delight.

In the evening there was a dinner in the great hall of the ancient castle, with a speech of welcome by the Governor of Uppsala. After dinner there was dancing before the return to Stockholm.

Apart from private dinners, luncheons and cocktail parties at some of the embassies, the only remaining general festive occasion was a farewell party in the famous town hall at Stockholm on the last night. The final plenary session at the concert hall preceded this. It was there agreed that future International Botanical Congresses should be held alternately in Europe and out of Europe at three- or four-yearly intervals after consultation with the International Union of Biological Sciences, and that the next should be at Paris in 1954.

It was further agreed that a Bureau of Plant Taxonomy and Nomenclature should be set up under the auspices of the International Union of Biological Sciences, and that an International Society of Plant Taxonomy should be established.

After the main business, a large floral wreath, to be placed on Linnæus's memoral at Uppsala, was presented to the president by Dr. E. D. Merrill on behalf of the foreign members of the Congress who, as "guests in a hospitable country", wished it to be accepted as a token of all that the Swedish botanists had done in ensuring that the Congress would be a success, and of their admiration of their illustrious countryman. Following this, representatives of the various delegations made speeches of thanks. The last in alphabetical order was the U.S.S.R. representative, who informed the meeting, in the characteristic Russian way, that Josef Stalin had decided that the chief aim of botanical studies was to convert plants to man's use ; and that the president in his address had been mistaken in assuming that certain intending members had been prevented from attendance—these botanists of free democracies had decided that the expression of their views could safely be left to the Soviet delegation. Lest there should be misunderstanding of this strange assertion it was stated three times in different words. It was stupid in the extreme, however, to think that anyone was deceived by such statements, for there had been no attempt to arrange that papers which had been sent in by those botanists were presented at the sectional meetings. The introduction of political polemics of this kind was an innovation at once stupid and ineffective in such an assembly. It was announced that the Russian delegates were to lay their own wreath on Linnæus's memorial.

Before the Congress proper there were some excursions for specialists and a Conference on Palynology. But the Section on Nomenclature spent a full week ploughing through a synopsis of the proposals put forward since 1935. Fortunately, a meeting of specialists held at Utrecht in 1948 had given an opinion on many of them, and thus broken the back of much discussion. It was heavy going, however, to work through 238 printed pages, and there was little of the evenings not occupied with committees. It was not possible to complete the discussions before the full Congress, and three additional meetings had to be held. Many decisions were taken which will make the Stockholm Congress noteworthy ; but it is devoutly to be wished that some degree of finality has been reached.

After the Congress there were several excursions. Those to Lapland were well attended, and both taxonomists and phytogeographers there spent a most profitable time.

There was only one shadow—the fear that international relations might again break the ordered sequence of botanical congresses.

OBITUARIES

Dr. S. Maulik

Samarendra Maulik, who died on July 9 at the age of sixty-eight, was born at Tamluk in the Gangetic Delta on December 25, 1881, and was educated at St. Xavier's College, Calcutta. Afterwards he undertook entomological field-work in Assam, studied at the Indian Museum, and joined the staff of the Forest Research Institute, Dehra Dun.

He first came to England in 1911. At Cambridge, where he took his degree, and at the Imperial College of Science and Technology, he read zoology and entomology. At the British Museum (Natural History) he worked on the Chrysomelidæ, a large family of beetles ; and in 1919 he published, in the "Fauna of British India", the first of his three volumes on the Chrysomelidæ of India.

He returned to India in 1919 as professor of zoology in the University of Calcutta, and successfully directed the initial organisation and equipment of the newly founded Department ; but he soon began to find the life uncongenial.

Within a year or two, therefore, he came to the British Museum again, and settled down—for the rest of his life, as it proved—to work on the Chrysomelidæ, acquiring a world-wide reputation as an authority on this family of some 25,000 species. He demonstrated the value of larval characters as an aid in unravelling true affinities, and discovered in the Halticinæ a femoral structure affording for the first time a clear diagnostic character for their separation from the Galerucinæ. Volumes issued in 1926 and 1936 completed his work on the Chrysomelidæ of India. In appreciation of another of his studies of faunas, he received a Royal Medal from the King of the Belgians. Altogether he published nearly a hundred scientific writings, most of them relating to the Chrysomelidæ, but others including, for example, the account of his recognition (with Stanley Hirst) of the most ancient fossil insect known, preserved in the Devonian Rhynie Chert. He made a number of short contributions to the columns of *Nature.*

During later life he collected from scattered sources about a hundred thousand records of the food-plants of chrysomelid species, and made a tabular summary classifying the records according to the plant families and chrysomelid sub-families simultaneously concerned. He found that the data fall into a definite pattern, from which it is possible to make predictions. It is hoped that the main outlines of this work, the full details of which are preserved at the British Museum (Natural History), will be published posthumously.

At the Museum, Dr. Maulik became a familiar figure. His portrait by Prof. Malcolm Osborne was exhibited at the Royal Academy. From 1934 the Museum recognized him as an unofficial scientific worker or associate. It is specially noteworthy that he built up for the Museum a considerable spirit collection of chrysomelid larvæ.

He had long been a fellow of the Zoological and Royal Entomological Societies and a member of the Société entomologique de France and of the Société linnéenne de Lyon. His D.Sc. was granted by the University of London in 1946.

Maulik was deeply interested not only in scientific subjects, but also in the whole field of human knowledge and endeavour. He was very widely read, and extremely fond of conversation and discussion. He attempted to adopt a scientific attitude in his approach to all problems. His views were liberal, and he was an atheist. In the *Bangalore Mail* and elsewhere he published about forty non-scientific articles on varied subjects. Though he retained a special interest in India, he knew in some respects more than many Englishmen about life in England. His conversation was often of great interest ; but his manner tended to be didactic, superficially vehement, and lacking in consideration for his listener. He was essentially kindly, however, and found it easy to make friends with most people, his circle of acquaintance being very wide and not limited by class distinctions. He took a real interest in the welfare of other people, and his genuine sympathy made it easy for them to confide their troubles. His advice helped many in their careers ; but he was less sure of himself in his own affairs. Had it not been for the care and support afforded him during thirty-three years by his wife, he could scarcely have accomplished so much work on the Chrysomelidæ.

Poor health during the past two years had necessitated spells in hospital; but in recent months, and until his sudden death from heart-disease, he was working as usual, still full of zest and looking to the future.

LESLIE BAIRSTOW

Mr. D. W. Amos, M.B.E.

THERE are a number of instances of laymen who have quite unconsciously aided the progress of medical science, but extremely few who have, by the pursuit of parasitological studies, added to existing knowledge. Among this company must rank the name of D. W. Amos, a business man who single-handed undertook medical research of a high standard. He lived and worked in Suva, Fiji, for twenty-two years as manager of the Pacific Insurance Co. until 1941, when he retired at the age of sixty-four, and he died there on July 20, 1949, aged seventy-two.

As his contribution to the Allied effort during the Second World War, Amos volunteered to supervise the anti-mosquito work at Nandi Airport (the main airfield of Fiji). This service was designed to prevent the importation of anopheles mosquitoes from the Solomon Islands by American bombers returning thence to their base in Fiji, and thus to guard these healthy islands against the introduction of malaria. During the course of his duties he studied entomology, paying special attention to the filaria-carrying mosquito of these islands—*Aëdes scutellaris pseudoscutellaris*—based upon my original work in 1910–11. In a short space of time he produced a training manual on the mosquitoes of Fiji, written in Fijian, as well as in English, designed for the instruction of Fijians and Europeans employed in the anti-mosquito service. During the course of this work he discovered a species new to the Fijian list and also new to science, *Aëdes* (*levua*) *geokusea* Amos, 1944. In 1943, coming into contact with an American medical officer, J. I. Knott, whose work on filariasis is well known, Amos became familiar with Knott's method of abstracting blood from the veins for the diagnosis of filariasis. Thus armed, he embarked upon a thorough survey of the islands and, together with his teams, was responsible for some 63,000 blood examinations, so that statistics compiled from these sources are invaluable.

While working on this survey, Amos came to realize that the vital part of the life-cycle of *Aëdes scutellaris* is the period of inactivity of this insect mmediately after a meal on human blood, when it rests upon bushes or upon grass in the vicinity of native huts. His idea was to interrupt the cycle at this point by clearing and maintaining an open space around all the *buris* (huts) in Fijian villages, and, in addition, to keep down breeding by destroying tins, oconut shells and other water-holding receptacles, combined with the filling of tree holes and other reeding-places of this mosquito.

By training Fijians of the anti-mosquito service in hese methods and by educating Fijian villagers in hese precepts, he was eminently successful; so that, or the first time in its history, filariasis as a menace o the community has begun to recede in Fiji. At s death Amos was mourned as the 'Father of the ijian people'.

PHILIP MANSON-BAHR

Prof. L. Breitfuss

WHILE on leave at Bad Pyrmont, the Nestor of polar research, Prof. Leonid Breitfuss, ex-councillor of State of the former Russian Empire, died on July 20, aged eighty-five. During his career of fifty years as a polar research worker, Prof. Breitfuss made a name for himself by his co-operation in the ten-year long Murmansk expedition undertaken by the Russian Empire in the nineties of the past century, and, in addition to that, by preparing and advising a great number of German and non-German polar expeditions. Among others were the expeditions in support of Nobile and Amundsen. He finally consolidated his name in polar research by the very important part he played in the foundation of the International Society for the Exploration of the Arctic by Aircraft, called for short 'Aero-Arctic', of which Fridtjof Nansen, the famous Norwegian oceanographer, polar research worker and philanthropist, was the president. Though this Society existed only for a short time, it nevertheless gained a lasting importance from the well-known polar expedition with the German airship *Graf Zeppelin* in 1931.

Prof. Breitfuss, initially a biologist, remained faithful to his first love (his special field was research into sponges) and yet succeeded in consolidating his fame as a historian of polar research far beyond the boundaries of Germany. It was but a short time before his death that, working in Hamburg at the German Hydrographic Institute (of which he had been a member since 1946), he completed his last great work, the "Polar Review". This work will be published by instalments in the "Geographisches Jahrbuch". With its reference list of several thousand titles, and its contributions of recent date, the review will be a comprehensive compilation of sources of value to all engaged in polar research. Its usefulness will extend also to geographers, to geophysicists and to scientific workers in marine economics, for example, whaling.

Many honours both from at home and abroad were recently conferred on Prof. Breitfuss in the house of the German Hydrographic Institute where he had taken up residence, when, some six months ago, he celebrated his eighty-fifth birthday in surprisingly good health and vigour. He was descended from a great Russo-German family whose ancestors were expelled from Salzburg by Bishop Firmian at the time of the confessional wars, but had, by the generosity of the electors and kings of Brandenburg, been allowed to settle in East Prussia. Later on, the family had moved thence to Russia.

It is much to be regretted that Prof. Breitfuss did not survive to complete from the rich store of his knowledge the "Standard Work of Polar Research" as he called it, for to do so had been his most ardent desire for many years. With his death we have lost one of the few surviving representatives of the 'heroic era' of polar research.

Dr. Brysson Cunningham

THE death occurred, on July 31, of Dr. Brysson Cunningham, an authority on dock and harbour engineering. He had contributed several descriptive articles to *Nature* on water-power developments in various parts of the world, all of them based on personal observations during his travels.

Dr. Cunningham was born in 1868 in Liverpool, and studied civil engineering at the University College there (now the University of Liverpool), while serving as an articled pupil of a local firm of engineers. He obtained the degree of bachelor of engineering from the Royal University of Ireland in 1895, and that of D.Sc. from Queen's University, Belfast, in 1915. In 1890 he had joined the Mersey Docks and Harbour Board, for which he prepared in 1902 an extensive scheme for new construction involving a cost of some four and a half million pounds. In 1906 he left Liverpool on appointment as resident engineer on new work for the London and India Docks Company, and became a member of the headquarters staff and personal assistant to the chief engineer of the Port of London Authority when that body was formed. In 1921 he went into private practice; during 1921–36 he was also lecturer on waterways, harbours and docks at University College, London. During this period he frequently attended meetings of the British Association, becoming a member of the General Committee, and was also very active on the Association's Research Committee on Inland Water Survey, a report of which led to the formation of the Inland Water Survey Committee, under the Ministry of Health, which has recently been reconstituted (see *Nature*, February 18, 1950, p. 263).

Although he retired some ten years ago and went to live at Eastbourne, he retained his interest in his own field; he had edited the *Dock and Harbour Authority* during 1920–26, and he returned to that task in 1937 and guided the journal through the difficult war years.

Dr. Cunningham's writings were marked by a preciseness characteristic of the man himself; small in build, meticulous in all things, he had enjoyed a full life of professional activity.

NEWS and VIEWS

Director of the Science Museum:
Dr. F. Sherwood Taylor

DR. F. SHERWOOD TAYLOR, curator of the Museum of the History of Science at Oxford since 1940, has been appointed director of the Science Museum, London, as from October 1, following the death of Dr. Herman Shaw in May of this year. Dr. Taylor was educated at Sherborne School, at Lincoln College, Oxford, and at University College, London. He was an assistant lecturer in chemistry in Queen Mary College, University of London, during 1933–38. His work in the history of science is well known. He is one of the founders and a member of council of the Society for the Study of Alchemy and Early Chemistry, and honorary editor of the Society's journal, *Ambix*. He took an active part in the foundation in 1946 of the British Society for the History of Science and has served on the Council of the Society and in the office of vice-president. He is a consulting editor of *Chymia*, the annual volume of studies in the history of chemistry published by the University of Pennsylvania. Dr. Taylor has published numerous books and papers, both on chemistry and on the history of science. Among these are his "Galileo and the Freedom of Thought", "A Short History of Science", "Science, Past and Present" and "The Century of Science, 1840–1940", and some interesting studies on Greek and later alchemy.

Endeavour Prizes at the British Association

AT the conclusion of his presidential address to the British Association at Birmingham on August 30, Sir Harold Hartley announced the names of the prize-winners in the scientific essay competition which has been sponsored by *Endeavour*, a quarterly review of science published by Imperial Chemical Industries, Ltd. The competition was for young scientific workers only, with the object of both stimulating their interest in the work of the British Association and encouraging the writing of good English. The response was considerably greater than was anticipated. 117 essays were submitted. The prize-winners are as follows: *First Prize of Fifty Guineas* to W. J. T. Dunstan (twenty-four years of age) for an essay on "Phenomena at Low Temperatures". He was educated at Stratford Grammar School, London, and at Wadham College, Oxford. In 1946 he became assistant in physics at University College, Dundee, and last year was appointed lecturer in physics at the Northern Polytechnic, London. *Second Prize of Twenty-five Guineas* to S. J. Adelstein (twenty-two) for an essay on "The Biological Significance of Trace Elements". He is an American citizen, and a graduate of the Massachusetts Institute of Technology. *Third Prize of Ten Guineas* is awarded to F. J. C. Rossotti (twenty-three) for an essay on "Radioactive Tracers". He was educated at Christ's Hospital and Merton College, Oxford. He served in Palestine in the R.A.F. until his demobilization in July 1948, and in October 1948 commenced at Merton College, where he is now in his second year. In addition, a special prize of five guineas has been awarded to R. D. Cohen (seventeen), of Clifton College, who sent in an entry of unusual merit for so young a competitor.

Association of British Science Writers

THE annual lunch of the Association of British Science Writers was held on September 1 in the University of Birmingham during the recent British Association meeting. Mr. Ritchie Calder (chairman) and Mrs. Calder and Dr. James Lawrie (hon. sec.) and Mrs. Lawrie received the guests, who included Sir Harold Hartley (president of the British Association), Sir Richard Gregory (founder-president of the Association of British Science Writers), Sir John Russell and Sir Henry Tizard. In a short address Mr. Ritchie Calder pointed out the necessity for such a body as the Association of Science Writers to ensure that properly trained and competent writers ar available to report and interpret the findings o scientific workers. In reply, Sir Harold Hartle stressed the great co-operation the British Associatio has always received from the Press, and the par science writers can and do play in keeping news o science in the foreground.

International Committee for Bird Preservation

THE annual report for 1949 of the British Sectio of the International Committee for Bird Preservatio describes the duck adoption scheme which wa launched by the Wildfowl Inquiry Committee at the end of 1948. Under the scheme, on payment of *5s.* the subscriber is allotted a duck and given particulars of its species, the number of its ring, and date and place of ringing, and later sent any news of it that is received. In addition, for the next two years after paying the subscription, a summarized annual report of all interesting recoveries is forwarded. When the scheme was announced through the Press the result was overwhelming, hundreds of applications for ducks being received every day. As a result the stock of ducks available for adoption ran out and a waiting list of would-be adopters was formed. About 1,700 ducks have already been adopted by more than 1,000 owners. The report also describes the work of the permanent commission on migratory game birds, the international conference of mountain sportsmen and the international union for the protection of Nature. During the year two new member nations, Greece and Spain, joined the committee, bringing the present membership up to thirty-six countries. Copies of the report may be obtained from Miss P. Barclay-Smith, c/o Natural History Museum, Cromwell Road, London, S.W.7, price *2s.*

Annual Report of the Textile Institute

THE annual report for 1949 of the Textile Institute, 16 St. Mary's Parsonage, Manchester 3, was presented at the recent annual meeting of the Institute, held at Leicester. Increased expenditure due to the rapid expansion of the Institute's work was partly met by increased membership subscriptions; but expenditure for the year again exceeded income, by £5,206. The total annual expenditure of the Institute is about £20,000, which is a minute fraction of one per cent of the amount spent by the textile industry, and it is suggested in the report that the income from industry might very well be considerably increased. A total of 777 new members were elected during the year, bringing the total membership on December 31, 1949, to 4,825. The inauguration of a South Wales and Monmouthshire Section of the Institute brought the number of sections and branches to fourteen. The Institute's *Journal* was issued during the year in two sections, separately bound, and its circulation rose to approximately 5,500 copies. Other publications by the Institute include "Fibre Science", "Jute", a further reprint of "Identification of Textile Materials" and the second issue of the Year Book. Entries in 1949 for both higher and ordinary certificates in textiles were the highest recorded, there being 205 candidates for the ordinary certificate and 93 for the higher, compared with 131 and 85 respectively in 1948. The successes gained in 1949 brought the number of ordinary national certificates awarded since the inception of the scheme in 1935 to 1,169, and of higher national certificates, 599. The increasing desire of students to attain the status of associateship of the Institute was shown by the growing number of entrants for the Institute's annual examination in general textile technology, for which there were 150 entrants, compared with the highest previous total of 114 in 1948. Applicants for associateship in 1949 numbered 218, of whom 75 were elected associates. Of 19 applications for fellowship, 17 were granted. The number of fellows in membership at the end of 1949 was 309, and of associates, 781. The first award of the new £1,000 scholarship was made to G. R. Haines, and the seventh award of the £750 scholarship (now to be offered annually) went to J. C. Hilton.

Noise and Sound Transmission

IN the summer of 1948 the Acoustics Group of the Physical Society held a symposium on noise and sound transmission, at which representatives from many countries attended. The proceedings of this symposium have recently been published in book form (pp. 200; London: Physical Society, 1949; *17s. 6d.*; to fellows and members of the Acoustics Group, *10s. 6d.*), and the forty-one contributions, though they vary considerably in size from a brief abstract in some cases to a lengthy detailed report in others, show that fundamentally the same problems are being tackled in different countries. The first half of the report deals with sound transmission. Leo Beranek, of the Massachusetts Institute of Technology, who was the official representative of the Acoustical Society of America, presents a paper on sound transmission through partitions. He describes experiments that he and others are conducting and which are aimed at, first, the development of a new method of measurement of the transmission and absorption of sound by panels, and, second, the verification that the attenuation of sound by multiple structures can be accurately calculated from the density, flow resistance and dimensions of the components. There are several important contributions from members of the National Physical Laboratory and of the Building Research Station. Much practical information has been collected with regard to sound insulation of party walls between dwelling houses. The articles on domestic noise, noise in schools, ships and aboard aircraft are very interesting, and many readers will be at once attracted to the paper on sound insulation between flats in the hope of finding a solution of this most urgent problem. The latter half of the report, dealing with noise measurement, commences with a review of the problem by R. S. Dadson, of the National Physical Laboratory, and in several of the subsequent papers noise-meters and instruments for the measurement of loudness, vibration, electrical interference, complex sounds and machinery noise are discussed. The report concludes with a written communication from the United States National Bureau of Standards on the transmission of reverberant sound through single walls.

Low-Alloy Steel Standards for Spectrographic and Photometric Analysis

EIGHT standards, representative of the low-alloy steel range, are now available for routine and research spectrographic analysis. The increased use of spectrographic analysis during and since the Second World War led the British Iron and Steel Research Association's Methods of Analysis Committee, through its subcommittee on spectrographic analysis, to put high on its programme the provision of standards. Work on the subject began late in 1946, and recommended compositions for two series, low-alloy steel and residuals, were drawn up. The manufacture, physical preparation and preliminary analyses of the low-alloy series has been undertaken under the supervision of the Bureau of Analysed Samples, Ltd. The eight standards are available in the form of half-inch diameter rod and are intended to cover a range of up to 5 per cent of the more usual alloying elements in steel, the iron content of each standard being approximately 94½ per cent. Analytical standardization has been carried out on behalf of the Methods of Analysis Committee by twelve co-operating chemists in industrial, government and research laboratories, including the Bureau. The steels are also available in the form of fine turnings as standards for photometric methods of analysis, as an alternative to standardization by means of pure metals. The turnings for photometric standardization are supplied in a series of eight bottles, each containing either 100, 50 or 25 gm. in each. Both the rods and the turnings are obtainable direct from the Bureau of Analysed Samples, Ltd., 234 Marton Road, Middlesbrough, or through any well-known laboratory furnisher.

American Committee for the Study of Alcoholism

THE Division of Medical Sciences of the United States National Research Council has recently set up a Committee on the Problems of Alcohol to initiate and support scientific research concerned with the varied actions of alcohol as a component of the diet or as a beverage and with the special social, psychological and medical problems created by its excessive consumption. The Committee consists of fourteen persons and includes representatives from industry as well as scientific fields bearing on research into alcoholism; the chairman of the Committee is Dr. Chauncey D. Leake, vice-president of the University of Texas Medical Branch, and Dr. Joseph Hirsh, of New York University, is the executive secretary. Information on the work of the Committee, including methods of submitting proposals for grants in support of research on problems of alcohol, may be obtained from the Secretary, Committee on Problems of Alcohol, Division of Medical Sciences, National Research Council, 2101 Constitution Avenue N.W., Washington 25, D.C.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: H. K. Ashby (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; G. T. Barnes (pathologist, Fiji), pathologist, Nigeria; D. A. R. Campbell (agricultural officer, grade 2, Jamaica), senior agricultural officer, Jamaica; H. G. Michaelides (forest assistant, Cyprus), assistant conservator of forests, Cyprus; P. E. Nesbitt (laboratory superintendent, Nigeria), senior laboratory superintendent, West African Institute, Trypanosomiasis Research, Nigeria; W. G. Stuart (agricultural officer, grade 1, Jamaica), senior agricultural officer, Jamaica; J. R. Low, agricultural officer, Uganda; K. McKerron, agricultural officer, Aden; J. K. B. Booth, geologist, Tanganyika; J. M. Brown, geophysicist, Geological Survey Service, Uganda; J. Dawson, S. MacDonald and A. Renwick, geologists, Federation of Malaya; A. Hatton and J. V. Hepworth, geologists, Uganda; P. N. Banks, W. D. C. Parkes and J. D. J. Ross, veterinary officers, Tanganyika; H. E. D. R. Williams, veterinary officer, Trinidad; J. A. G. Glenn, game ranger, Tanganyika.

Announcements

DURING the meeting of the British Association at Birmingham, the honorary degree of D.Sc. was conferred on Sir Harold Hartley, president of the Association, at a congregation held in the Great Hall of the University on September 2.

MR. T. C. DENSTON has been appointed secretary of the British Pharmacopœia Commission in succession to Dr. C. H. Hampshire, who will retire on October 3.

OWING to the growth of the garden work and investigations at the John Innes Horticultural Institution at Bayfordbury, it has been found necessary to separate the research and administrative sides of the Garden Department. Mr. W. J. C. Lawrence who, as curator, has been in charge of all the cultivations and research on cultivations since 1932, has been appointed to the purely research post of head of the Garden Research Department, where he will be free to continue his investigations on all aspects of indoor and outdoor cultivation. Mr. J. Newell, who has been assistant curator since 1936, becomes curator in charge of the garden administration at Bayfordbury.

THE annual conference of the Society of Leather Trades' Chemists will be held in the University of Leeds during September 22–23. On the afternoon of September 22 the fourth Procter Memorial Lecture, for which tickets are available to non-members, will be given by Prof. E. K. Rideal, his subject being "Membrane Permeability". Further details of the conference can be obtained on application to the editorial office of the Society at Craigieburn, Duppas Hill Road, Waddon, Croydon, Surrey.

THE Industrial Applications Section of the Royal Statistical Society is organising a conference, to be held in the University of Sheffield during September 29–October 1, on "Scientific Method in Industrial Production", when technicians and managements of manufacturing concerns will be able to meet statisticians interested in industrial problems. The papers on the first day have been particularly designed for non-statistical audiences. Applications for attendance at the conference (fee 1 guinea) should be sent to the Assistant Secretary, Royal Statistical Society, 4 Portugal Street, London, W.C.2.

A SYMPOSIUM on "High-Temperature Steels and Alloys for Gas Turbines" has been arranged by the Iron and Steel Institute and will be held under the chairmanship of Mr. J. R. Menzies-Wilson, president of the Iron and Steel Institute, in the lecture theatre of the Institution of Civil Engineers, Great George Street, London, S.W.1, during October 18–19. The provisional list of papers has been classified into the following sections: introduction, user aspects, supplier aspects, performance aspects (scaling and hot-fatigue), special casting techniques, welding aspects, special blade materials, and research and future needs. Before the symposium, the fifth Hatfield Memorial Lecture will be given by Sir Frank Whittle in the lecture theatre of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, at 8.30 p.m. on October 17. Tickets for the symposium and Hatfield Lecture are available to non-members of the Institute. Further particulars can be obtained from the Secretary, Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1.

ERRATUM. In the communication by K. O. Müller on "Hypersensitivity and Tumour Development in Potato Tubers in Response to Infections with *Phytophthora infestans*" in *Nature* of August 5, p. 231, paragraph 1, last line, for "hypersensitive" read "hyposensitive".

CIVIL ENGINEERING PROBLEMS IN COLONIAL TERRITORIES

THE second Conference on Civil Engineering Problems in the Colonies, organised by the Institution of Civil Engineers, took place in London during the week July 3–7. Among those present were engineers from most of the British Colonies as well as from the Sudan and French Morocco, the attendance being a 30 per cent increase on that of the first Conference held in 1948.

One of the technical sessions was devoted to a series of short papers on "Engineering Research and the Colonial Engineer", in which the directors of the establishments of the Department of Scientific and Industrial Research more directly connected with engineering reviewed those aspects of their work of particular Colonial interest. Dr. W. H. Glanville, director of the Road Research Laboratory, compared the different factors affecting the design of roads and the selection of road-making materials in the United Kingdom and the Colonies. He instanced the differences in climate and soils, stressing in particular the need for a better classification of lateritic soils, and he discussed the differences in traffic intensities and the means and methods of construction. As yet no permanent solution to the corrugation of earth has been found. He welcomed the setting up in a number of Colonies of laboratories to examine and control road-making materials, and hoped that the recent appointment of a Colonial liaison officer at the Road Research Laboratory would assist in the circulation of information on Colonial road problems.

Dr. F. Y. Henderson, director of the Forest Products Research Laboratory, said that there is an increasing interest in Colonial timbers, and a building in which tropical conditions could be simulated is nearing completion. The Laboratory is now providing a six months course for Colonial forestry officers who are to specialize in timber utilization, and its short courses for public works department engineers have proved very successful.

Sir Claude Inglis, director of the Hydraulics Research Organisation, outlined the work this body would be undertaking as soon as its laboratory is opened.

Dr. F. M. Lea, director of the Building Research Station, referring to some of the problems in which the work of the Station could help the Colonial engineer, discussed the use of stabilized earth for walling and the uses which could be made of local materials, such as lime, gypsum and pozzolanas in place of Portland cement. He also mentioned the care required in using new types of aggregate in concrete which might react with alkalis in the cement. Of the Station's work on structures, he discussed the use of alternative cements in concrete to increase its resistance to deterioration, and the work on steel frameworks and the design of bridge-deck slabs in relation to steel economy. The work of the soil mechanics division is of particular interest, especially in relation to the design of foundations on expansive soils which are subject to seasonal movement, and to the problems of soil erosion and special types of soil which occur in the Colonies.

Dr. B. A. Southgate, director of the Water Pollution Research Laboratory, pointed out that the work of that Laboratory includes the development of methods of treatment of polluted water and of sewage and industrial waste liquors, as well as the investigation of the effects of pollution on natural waters. Many requests for advice and assistance on these problems are received each year, some of them from the Colonies, where correspondents—usually public health officers—have been appointed by the Colonial Office. Some work has been carried out by the Laboratory's staff on the treatment in East Africa of waste waters from the processing of coffee and the decortication of sisal.

In a paper on "Investigations and Construction of Tropical Water Supplies", Mr. D. S. Bulbin described work carried out during his twenty-one years in the Public Works Department, Nigeria. One of the most troublesome problems with which the engineer in the Colonies is confronted is the inadequacy of the data available on which to design public water supplies. In Nigeria the only topographical survey sheets—to a scale of 1 : 125,000 with contours at 50 or 100 ft. vertical intervals—suitable for determining water catchment and reservoir areas cover about one-sixth of the country. A start has, however, been made with aerial surveys which will greatly assist this work. It is difficult, because of the range of conditions in Nigeria, to establish percentage-variations from the average rainfall at different stations. For example, in 1946 a new minimum was recorded at the head works of the Lagos water-supply which was about 50 per cent of the 35-year average. There is also little information on rainfall-intensities. The only available self-recording rain-gauges were designed for United Kingdom intensities, and, because they magnify the fall on the chart, are not suitable for the measurement of tropical rainfall-intensities. He had therefore designed a 5-in. gauge which records the rainfall on a continuous direct-reading weekly chart, 1 in. of rainfall being represented by ½ in. on the chart. The maximum capacity of the container is 24 in., which is ample for most places in Nigeria. The device has been built up locally, the clock drum, float, pen and charts being imported.

The only reliable method of arriving at run-off figures from a catchment is by direct stream-flow recording, and this is being done so far as possible in Nigeria, though rainfall figures must necessarily give the first indication of the possibilities of a catchment area. One of the problems is that rainstorms are very localized. Another is that the widths of streams and rivers may not bear any relationship to the area draining into them. Considerable variation in run-off figures has been observed; but, for actual design, an overall figure of 22 per cent of the total rainfall is being adopted. A further aspect of run-off, experienced in the southern area during the past few years, is the drying up of large rivers with catchment areas running into many hundreds of square miles. The area has normally an ample rainfall and the cause of this drying up is difficult to understand, one probable cause being the shifting cultivation methods of the African farmer, which encourage a quick run-off during the rainy season with little rain penetrating into the ground. The lack of reliable information about the run-off also makes the calculation of flood-flows difficult.

A further problem is the estimation of water consumption for any scheme. Reliable population figures are rarely available, but, as taxes are usually levied on the adult male population, a simple though approximate method is to multiply this number by a factor, normally 3·6. The floating population, always considerable in market towns, is another unknown factor, and in Northern Nigeria large numbers of animals have also to be watered. For new schemes, a consumption of 10 gallons per head per day has been adopted, and in addition provision is made for hospitals, schools and for the railway.

In the north, the sand beds of large rivers which cease to flow for some five months of the year are often the only possible source of supply, and an improved type of well-intake in sand has been designed. No large dams have yet been built in Nigeria, but earth embankments with an impervious core and straight concrete overflow-weirs have been used. Since about 80 per cent of the population is rural, the provision of rural water supplies is very important, and a considerable amount of work has been carried out in this field.

Two papers were devoted to the problems of Colonial railways and ports. The first, presented by J. R. Farquharson, discussed the "Railway and Port Problems in East Africa". There has been a steady growth of traffic on the railways and through the ports since development began in East Africa at the beginning of the century. The rate of increase of traffic has been particularly rapid during and since the Second World War, when it was difficult to obtain staff and supplies. Increased demands on the transport services have necessitated works and improvements of all types. These include the provision of housing for railway staff, some major reconstructions of station workshop buildings and the rearrangement and strengthening of the track between Nairobi and Nakuru in Kenya. Other sections are shortly to be strengthened. At the same time it has been necessary to construct new lines to serve specific projects, of which the two principal are the 130-mile line to the Mpanda line in the western province of Tanganyika and the 160-mile railway in the southern province of Tanganyika constructed solely to meet the requirements of the Overseas Food Corporation.

Various other projects for the extension of the East African railway system have been considered at intervals during the past quarter of a century, the four main projects being, first, a connexion between the Tanga and Central lines in Tanganyika; secondly, a line southwards from the Tanganyika Central line, ultimately linked with the Rhodesian system; thirdly, a line to serve the coal-fields of southern Tanganyika, connecting either with the projected line between Tanganyika and the Rhodesias, or with the new line in the southern province; and fourthly, a line from Kampala to serve western Uganda and (ultimately) to join the transport system of the Belgian Congo. Mr. Farquharson commented on each of these projects. He thought the Tanga and Central lines in Tanganyika are likely to be connected during the next ten years or so, and that the time might soon be ripe to start construction on that part of the proposed link with Rhodesia serving the Njombe area of Tanganyika, although differences in gauge between the two systems will complicate the completion of this link. The examination of the coal-fields in the Ruhuhu valley, north-east of Lake Nyasa, is not yet completed, and until the probable markets for the coal and its derivatives can be more clearly determined, it is difficult to advise on railway development in this area. A preliminary survey of a line from Kampala to the Uganda–Congo border was completed in 1930, but it was not built then because of the onset of the economic depression. However, interest in the copper/cobalt occurrence at Kilembe, in the Ruwenzori mountains, has recently been revived.

The second paper at this session was devoted to harbours and wharfs in the Colonies, and was presented by R. D. Gwyther. In a great number of ports in the Colonies the handling of goods between ships and shore has been carried out by lighterage; but the greatly increased trade developed by the Dominions and Colonies, from which increased revenue has been derived, has, in many cases, enabled deep-water berths to be provided. Wharfs have been, or are about to be, constructed in several ports, and their design is therefore of considerable interest at the present time. After pointing out the advantages of adopting the solid type of structure, Mr. Gwyther dealt with the various matters such as width of apron, type of sheds, and the arrangement of rail tracks, cranes and fittings which are required to facilitate the handling, storage and clearing of cargo. Reference was also made to the provision of oil-berths and the bulk loading of certain commodities. He then described some of the new harbour works at present being carried out in British Colonies; such as wharfage extensions at Lagos, Nigeria and Takoradi, Gold Coast, and new harbour works at Freetown, Sierra Leone, and Mtwara, Tanganyika. Finally, as a comparison with the modern blockwork quay wall, an earlier type of quay was described, constructed about sixty years ago at Castries, in the West Indies, which has stood the test of time, and proved adequate for the purpose for which it was designed.

Other papers were devoted to the construction of roads and airports. A. J. Mitchell spoke on "Survey and Design of Low Cost Roads for Colonial Conditions, with special reference to the Principles of Soil Mechanics". Recent advances in the science of soil mechanics have had far-reaching effects on highway engineering, particularly the branch dealing with low-cost roads which, for economic reasons, have to be employed extensively in the Colonies. By the application of the principles of soil mechanics to this type, in which the soil, gravel or other material in the road bed itself forms the greatest part of its composition, it is possible to produce a road which will maintain an adequate degree of stability under a considerable range of traffic and weather conditions, at a cost which is often considerably lower than that of some traditional construction. Mr. Mitchell described a scheme of work covering the operations of reconnaissance, detailed survey and design of the road, based on recent experience in Tanganyika. He discussed the various methods for the improvement of the foundation and of the base-course, by soil stabilization, compaction, etc., and the current methods of designing the thickness of flexible base-courses. An analytical method of design has been worked out, largely derived from the work of previous investigators, which has the advantage of being based on the accepted theories of soil mechanics and related to standard soil tests. A simpler empirical method was also suggested for use in conditions which do not justify the former method. The paper concluded with a discussion of the problem of subsequent maintenance of the road surface so far as this affects design, and recommendations were made for the design of bituminous and non-bituminous surfaces.

The second paper on road and airport construction, by W. R. Scott, was on "The Design and Construction of the Livingstone Airport, Northern Rhodesia’

The increase in air traffic throughout the Colonies since the end of the Second World War has necessitated the construction of many new airports. In some Colonies these have had to be of very heavy construction in order to be capable of handling the large airliners operating on the main trunk routes. Internal air-traffic, while it may need the provision of only short and comparatively narrow runways and light pavements, depending upon the frequency of the services, often calls for elaborate ancillary equipment and accommodation to house it. Such facilities could be, and usually have been, provided by improving pre-war airfields. However, with the advent of heavy transcontinental airliners operating on the main trunk routes, it was found that there were few existing runways which could, economically, be extended and strengthened to the necessary standards; furthermore, even if expansion were economical, the requirements for clear flightways and safety zones could not be fulfilled; that factor alone dictated the need for entirely new sites. The Livingstone project called for runways, buildings, and other facilities for handling both increased feeder-traffic and large transcontinental traffic. Mr. Scott, who, as resident engineer under instructions from the Director of Public Works of Northern Rhodesia, prepared the scheme and supervised the construction, described the work undertaken.

During the conference, visits were arranged to various works and research stations. The opportunity was also taken of the visit to Britain of Prof. Gordan M. Fair, of Harvard University, who gave a talk on the development of public health engineering in the United States.

OIL SHALE AND CANNEL COAL

THE second Conference on Oil Shale and Cannel Coal was held under the auspices of the Institute of Petroleum at Glasgow during July 3–7, when nearly fifty papers, covering a wide range of subjects, were presented and discussed. The papers were divided into two sections: (*A*) geology, mineralogy and mining; and (*B*) retorting, refining and use of by-products. No attempt has been made in the present review to make a comprehensive statement covering all—or nearly all—the papers, nor are the following remarks divided in accordance with the above classification. It has seemed better to concentrate on certain outstanding features of the Conference, as giving an outline of some of the subjects which will be treated in detail in the complete report to be issued later by the Institute of Petroleum.

It is noteworthy that interest in the development of the oil shales as a source of liquid fuels is not confined to those countries whose resources of well-oil are negligible or entirely absent; intensive work has also been carried out by the Bureau of Mines in the United States with the view of working out a basis for the re-establishment of the oil shale industry in that country. It may not be generally realized that, following the pioneering work of Dr. James Young in Scotland during the 1850's, a number of firms in the United States produced oil by the retorting of oil shales; but the inception of the petroleum industry, which arose when, in 1859, Colonel Drake sank the first well for the specific purpose of producing oil, resulted in such a reduction of costs that the oil shale industry was unable to compete. The increased cost of finding and winning oil from wells has, however, rendered it possible that before many years have elapsed it may be economic, and even necessary, for technologists in the United States to turn their attention to the production of oil from retortable materials.

One of the difficulties which confronts him who would write or speak of oil shales and similar materials is the absence of any comprehensive classification and standard nomenclature. Although at the previous conference, which was held in 1938, a resolution was passed inviting the Institute of Petroleum to take steps to secure a standard nomenclature, the advent of the war in 1939 prevented the implementation of this resolution, and there is still no satisfactory classification or system of nomenclature. R. A. Mott (Sheffield) proposed to divide the canneloid materials into 'coals' (cannels, cannel bogheads, boghead cannels and bogheads or torbanites) and 'shales' according as they yield less or more than 40 per cent ash when incinerated. The 'coals' are subdivided on a basis of yield of volatiles (calculated on the dry mineral-free basis) and specific gravity. G. W. Himus (London) discussed the little that is known of the composition and constitution of the kerogen rocks, pointing out the wide variation in composition and nature both of the organic and mineral components. He directed attention to the fact that what are generally called 'oil shales' may be limestones, true shales, quartzose silts and of intermediate types; therefore the name 'shale' applied simply on a basis of yield of ash may be misleading.

C. H. Prien (Denver, Colorado) summarized the history and what is known of the occurrence and geological origin of oil shale and shale oil, and the various methods of retorting which are in use. J. A. Dulhunty (Sydney) gave an account of the occurrence and origin of the Australian torbanite, which is a good example of a deposit of algal origin, almost free from admixture with other materials.

Numerous papers dealt with methods employed in mining oil shale. Room and pillar methods appear to be the most favoured, although J. M. Caldwell, J. Stein and R. Keddie (Scottish Oils, Ltd.) described the application of longwall working at Broxburn. Until the advent of more robust plant than was available prior to 1940, coal-cutters were considered to be unsuitable for use in shale mines owing to the harder and heavier nature of oil shale. E. D. Gardner and E. M. Sipprelle (United States) gave an account of the methods of mining the Mahogany Ledge of the Green River shales at Rifle, Colorado. The bed is 27 ft. thick, and after the rock has been blasted, the broken shale is loaded by a 3-cu. yd. electric shovel into 15-ton diesel trucks for conveyance to the surface. An output of nearly 150 tons per man-shift underground has thus been secured.

The normal procedure in the production of shale oil involves winning the shale, transporting it to the carbonizing plant, carbonizing at approximately 500° C., and condensing the oil. A revolutionary method of recovering shale oil by carbonizing *in situ* was invented by F. Ljungström and was described by G. Salomonsson (Sweden). A comprehensive research was first undertaken, during which the method was treated mathematically, chemically and physically, and, having been found to be feasible, a full-scale plant was erected by the Swedish Shale Oil Co. at Norrtop. The seam of shale is about 55 ft. thick, dips gently to the south, and is covered by a bed of limestone, 20–23 ft. in thickness, which forms a gas-tight 'roof' preventing leakage of the vapours. The shale is heated by about two thousand electrical elements arranged in a hexagonal pattern, with offtake pipes for the vapours between them. The final temperature is about 400° C., and the pressure generated is sufficiently high to force the vapours up the pipes in the centres of the hexagons through the condensing plant. As the heating of one part of the rock is finished, the heaters and offtake pipes are moved forward, the rate of travel being about 460 ft. a year. The actual time of heating of any one section of the shale field is about five months. The oil is condensed in specially designed forced-draught, air-cooled condensers, and the light vapours are then recovered by scrubbing the gases with crude oil. The gases, which contain 25 per cent sulphuretted hydrogen, are treated in an Alkazid–Claus plant for the recovery of sulphur and are then used as a fuel in a power plant. The calorific value is 955 B.Th.U. (gross), or 870 B.Th.U. (net) per cu. ft. The consumption of power is 6·4 kWh. per litre of oil, and the yields per sq. m. of ground are: oils (containing 50 per cent gasoline boiling to 200° C.), 1,025 litres; liquid propane and butane, 80 kgm.; washed gas, 650 cu. m.; sulphur, 320 kgm.; and ammonia, 8 kgm.

A novel and interesting retort was described by C. Berg (Union Oil Company of California). The plant is designed to reduce the cost of retorting and also to avoid the use of water for condensing the oil. To effect the latter, the retort is fed with raw shale from the bottom, and distillation takes place downwards, the cold incoming shale being used to condense the oil vapours. Heating is carried out by burning the carbon in the spent shale by drawing a current of air downwards through it; transfer of heat is thus effected by convection, and therefore large cross-sectional areas can be effectively heated and large throughputs obtained.

J. Givaudon and P. Dumoutet (France) described tests on the utilization of calcareous shale of Dotterhausen (Würtemberg). Carbonization is carried out in an internally heated, continuous brick retort, the heat necessary being supplied by burning the residual carbon in the shale. The spent shale can be used directly as hydraulic lime. The retort is approximately 8 ft. by 8 ft. in cross-section, 37 ft. high, and has a throughput of 50 tons a day, and it is claimed that, owing to the wide range of possible operating conditions, any quality of shale can be handled. The shale of Dotterhausen is of low grade, yielding 4·35 per cent by weight of oil in a laboratory assay; in the Carburants et Lubrifiants retort, yields of 4 per cent oil have been obtained.

In contrast to the above are the Westwood retorts of Scottish Oils, Ltd., described by G. H. Smith and A. Balloch. These retorts, of which there are 104, arranged in two benches, at Westwood, are a modification of the Woodall–Duckham continuous vertical, with a 14-ft. cast iron section above a 20-ft. section of firebrick. About two-thirds of the heat required is supplied by burning the carbon of the residual shale within the retort, while the balance is supplied by combustion of the stripped gas in flues built around the retorts. The throughput of each retort is approximately 12 tons a day.

R. Labourel (France) described the method of utilizing the 15 per cent of fine shale which is produced at the mines at Autun, and which was previously thrown to waste as being unsuitable for charging into the retorts. This material is now finely pulverized and burned under boilers; and, as the result of a continuous run of twelve months, the problems arising in the combustion of the pulverized shale have practically been solved. It has been established that, if utilized where it is extracted, the pulverized shale from Autun compares favourably with coal for the production of steam.

A number of papers were devoted to the subject of refining (including hydrogenation) of shale oil. The methods employed are based on those of the petroleum industry, certain modifications being necessary to cope with the special characteristics of the raw materials.

Scottish Oils, Ltd., have made a successful incursion into the highly competitive brick industry at their Pumpherston works, and the plant was described by A. Anderson and J. McCallum. The principal material used is spent shale, which must be well weathered to ensure that all the carbon has been burned off and the iron oxidized to the ferric condition. The carefully selected spent shale is first dried, then crushed in a rod-mill, after which it is mixed with the requisite quantity of calcium hydrate (partly dry, and partly as a slurry) in an edge-runner mill. The plastic material from the mixer is then passed through two duplex fourteen-stamp brick presses, each of which produces forty-two bricks per minute. The bricks from the presses are loaded on to bogies which are then run into autoclaves, where they are subjected to steam-curing at 145 lb. per sq. in. and a total temperature of 480° F. When discharged from the autoclaves, the bricks are ready for dispatch. Immediately after curing, the bricks exhibit a white to pink appearance; but all whiteness quickly vanishes, leaving a pleasant, somewhat variegated pink surface. The capacity of the plant, working three shifts, is 80,000 bricks per twenty-four hours; production at the present time is 32,250 bricks, working a single shift on each press. The crushing load averages 31 tons per brick (wet) or 34 tons per brick (dry), and the absorption of water is 12 per cent of the dry weight, although this varies somewhat, depending on the grading of the mixture and the compression in the brick press. The brickmaking project was commenced in 1934, more to provide employment than to reduce the unsightly bings of spent shale which are such noticeable features in the oil shale field; indeed, only 110 tons of spent shale are used daily, while several thousand tons are produced by the crude-oil plants each day.

As a result of joint work by Scottish Oils, Ltd., and the Anglo-Iranian Oil Co., Ltd., synthetic detergents are now being manufactured at the works at Pumpherston; the process was outlined by D. Stewart and E. McNeill. The raw material is a shale oil fraction having a boiling range of approximately 180–330° C. After being washed with dilute sulphuric acid and then with caustic soda to remove nitrogenous bases and tar acids and phenols, the oil is redistilled. The distillate is treated with 96–98 per cent sulphuric acid, whereby the olefins are converted into a mixture of alkyl and di-alkyl sulphates, together with some polymer tar. The latter is separated in centrifugal separators, the tar flowing to a separate plant where sulphuric acid is recovered and the organic portion of the tar prepared for use as fuel The 'sulphated oil' is neutralized by a solution o sodium carbonate, the mono-alkyl sulphates being converted into sodium salts. The sodium alkyl sulphates immediately emulsify the unreacted oil to a cream-coloured emulsion. The temperature is then raised to 90° C., and by maintaining these conditions for five to six hours the yield of monoalkyl sulphates is increased by hydrolysis of the di-alkyl sulphates. After the batch has been cooled, the emulsion is broken by the addition of weak *iso*propanol. Two layers form, the upper consisting of unreacted oil and alcohol, the lower of an alcoholic solution of sodium alkyl sulphates with unreacted mineral oil and excess alkali. The upper layer is redistilled for the recovery of alcohol, while the oil is returned to the refinery for processing to diesel oil. The alcoholic detergent layer is freed from mineral oil by washing with suitable solvent spirit, after which it is concentrated and freed from alcohol and solvent spirit (which has replaced the unreacted oil), and finally leaves the evaporators as a syrupy liquid.

The Conference was well attended, and there were lively discussions on some of the papers. It is apparent that there is widespread appreciation of the importance of the oil shales and related materials as potential sources of oil, and much experimental and pioneering work is being carried out on the production and refining of shale oil. There seems, however, to be comparatively little work in progress on the more fundamental aspects of the chemical composition and constitution of the oil shales ; therefore there is a lack of balance in the picture as presented by the Conference.

THE VETERINARY PROFESSION IN INDIA

IN his presidential address to the tenth All-India Veterinary Congress held last April in Bombay, Dr. S. Datta, director of the Indian Veterinary Research Institute, Mukteswar, appealed for the creation of an Indian veterinary council, which should be a statutory body set up by Act of Parliament, with power to enforce a high standard of veterinary education in Indian veterinary colleges, to suppress quackery in the veterinary profession and to co-ordinate the work of the various State veterinary departments. Dr. Datta also urged the creation of an all-India veterinary association with affiliated State associations, the function of which would be to look after the interests of Indian veterinarians.

The reasons why India needs a higher standard of veterinary education and a better co-ordination of veterinarians and their work were discussed in the course of Dr. Datta's address. He deplored the lack of interest shown by the State and the public in the welfare and improvement of farm stock, and rightly urged that veterinarians should not merely wait until disease occurs and then try to remove or prevent it. Directing special attention to the importance of Indian cattle, he said that agriculture in India is really dependent upon animal husbandry, because farm animals in India are often the only source of power for agricultural work and they supply, in dry areas, the motive power for land-irrigation ; they are the mainstay of transport in agricultural areas and the chief source of manure. Assessing the individual values of transport, manure, hides, milk and milk products, eggs and wool, Dr. Datta estimated that the income derived directly and indirectly from farm stock represents two-thirds of the Indian national income. Apart from the control of the preventable diseases which cause heavy losses, there is urgent need for the establishment of good pastures, the preservation of grasses as hay or silage, the utilization of slaughterhouse waste, and the preparation and distribution of processed livestock foods. But these are only short-term measures ; they cannot succeed unless scientific systems of breeding are also established, by means of which the number of animals can be reduced and their productivity increased.

Urging State participation in this policy, Dr. Datta regretted that at present the State spends on veterinary projects and animal husbandry only 0·08 per cent of the total budget grants. He described a programme for the development of disease control and animal husbandry and discussed the lack of properly educated veterinarians. India has only 10 veterinarians per million head of livestock, whereas Great Britain has 95 and Switzerland 248. India, said Dr. Datta, requires developments in veterinary education equal to those which have occurred in Britain and other countries. Although new Indian veterinary colleges have been established and a better scientific education is being given, the men who are giving this education have been drawn from the Mukteswar Institute, and the demand for leaders of this kind is now greater than the supply. The existing plans for the enlargement and reorganisation of the veterinary profession upon which the supply of leaders depends should therefore not be held up any longer, and an Indian veterinary council is required.

Dr. Datta's views will be supported by everyone who is interested in the welfare of India, whether they see the future of this great country from the outside, or have been, until recently, quietly laying the foundations upon which the reorganisation outlined by Dr. Datta could be brought into being. Quite apart from political or economic considerations, this reorganisation and development is urgently required for the sake of the farm animals themselves.

G. LAPAGE

EVOLUTION IN BACTERIA AND THE SIGNIFICANCE OF THE BACTERIAL SPORE

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THE tendency of most groups of living creatures to evolve from a condition in which structure and function, and especially the reproductive and distributive functions, are adapted to an aquatic existence, to a terrestrial form, is clearly discernible in bacteria.

Purely aquatic bacteria are of three main types, of which one is free-swimming and two are sessile. The free-swimming bacteria are more or less spiral in form, much more so than the truly terrestrial bacteria. The sessile bacteria may be stalked (caulobacteria) or filamentous (chlamydobacteria), or, in some cases, both. Thus bacteria may make use of, or resist, the distributive potentialities of the water.

Bacteria of many other types are found in water ; but some are unquestionably there by accident, and only the spiral and sessile forms appear to be specifically adapted to an aquatic existence.

Distribution, under aquatic conditions, does not present a serious problem. The spiral forms swim freely and their non-motile, resting stages, where these exist, drift in the currents. The sessile forms usually possess a motile stage, by which distribution is effected. The swarm cells of chlamydobacteria and the flagellated generation of caulobacteria[1] perform this function.

Although there is little direct evidence, I am inclined to the opinion that the spiral water bacteria, with their polar flagella, are the ancestral bacterial form.

Caulobacteria and chlamydobacteria have no terrestrial representatives and may be regarded as highly evolved for life in very dilute nutrient media, such as streams and lakes.

As in the case of plants and animals, many bacterial species which are terrestrial in habit possess features indicative of an aquatic origin. Of these, the tendency towards a spiral morphology[2] and the possession of flagella are obvious examples. In certain terrestrial species the flagella have been developed to such an extent that the organism is capable of active movement upon a surface that is no more than damp. This is characteristic of *Proteus* and of many sporing genera. The flagella of these bacteria are not, so far as is known, different from those of other species, but are exceedingly numerous, and are peritrichous in arrangement. The flagella of aquatic bacteria, by contrast, are usually few in number and confined to the poles of the cell, and such bacteria often swim more actively than those with peritrichous flagella.

Many species, less completely adapted to terrestrial conditions, possess flagella which are apparently of little use to them. For example, bacteria of the *coli-typhoid* group are capable of swimming actively, although this function can be of little service to them. It is, however, noteworthy that when typhoid bacteria are swimming freely, many of their flagella become twisted together into a tail at the end of the cell[2]. This may be a device for greater efficiency, or it may be merely an accident. Whatever the explanation, the inference that peritrichous flagella are imperfect swimming organs is difficult to escape. It is also worthy of note that the polar or sub-polar flagella of *S. typhi* are the first to develop in the germinating microcyst[3]. The theory of recapitulation is not now held to be entirely true, but it is of some interest in such a case. The commonest free-living genera of this group are actually non-motile and depend upon passive distribution, apparently with success.

The problem of adaptation to movement upon dry land has been solved in an entirely different manner by the Myxobacteria, which have discarded flagella entirely, and with them the rigid cell wall of the eubacteria. Myxobacteria crawl upon solid surfaces, or surface films, by muscular activity of the cell wall. They cannot 'swim' when they are immersed in a fluid. They have also achieved a solution of the problem of distribution of the species under terrestrial conditions.

As has already been suggested, the distributive units of aquatic bacteria are motile cells. On dry land, however, this type of motility is inadequate to ensure distribution, and the most successful groups have evolved mechanisms for ensuring carriage of endospores, microcysts, or oidia by the air.

The Myxobacteria produce fruiting bodies, of which the most elaborate are very well designed for this purpose. They range from mere heaps of microcysts to complex structures with a large surface area to catch the air, borne upon long stalks[4]. Each fruiting body contains many microcysts, so that, upon germination on a suitable substrate, an entire vegetative swarm is released. This must ensure, to some extent, that the newly germinated bacteria are not overgrown by those already present.

Two other groups which have developed parallel mechanisms are the Streptomyces and the sporing bacteria. The fungus-like habit of the former needs little comment. Spores are borne upon aerial hyphæ, and combine large numbers with small size to ensure distribution. The sessile, plant-like organism is entirely immobile. The sporing bacilli are less specialized, but almost equally successful, and have produced the rather puzzling endospore. It seems to me that the main function of the spore is aerial distribution. It is probably no more than the eubacterial microcyst[5], considerably reduced in size for the sake of lightness and, therefore, concentrated. It is this concentration of the protein, by the elimination of water, that is responsible for the resistance of the spore to inimical agencies. This can scarcely have developed because of any real advantage which its possession gives to the species. High temperatures and strong concentrations of chemicals are rarely met with in Nature; whereas the resistance of the spore to oxidation and inanition is little, if any, greater than that of the resting stage of other types of bacteria.

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A METHOD OF INTEGRATING THE GIBBS ADSORPTION ISOTHERM

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THE force (π) – area (A) relationship for the adsorbed film of a soluble substance can be obtained from the equilibrium surface pressure (π) – concentration (c) curve by a graphical application of Gibbs's adsorption isotherm. This can be applied in two equivalent forms:

$$n = \frac{c}{kT} \cdot \frac{d\pi}{dc}, \qquad (1)$$

$$n = \frac{1}{kT} \cdot \frac{d\pi}{d\ln c}, \qquad (2)$$

where n is the number of molecules/cm.^{2} = $1/A$ (assuming that the activity coefficient is unity).

A study has been made of the application of these equations to solutions of normal aliphatic alcohols, and it has been found that (1) is not readily applied in regions of high curvature of the $\pi \sim c$ curve (π greater than 15 dynes/cm.) owing to the large error in the graphical determination of $d\pi/dc$. Use of (2) indicates a region of constant adsorption which, from surface potential measurements, does not exist. Thus equation (2) tends to smooth out the significant changes in $d\pi/d\ln c$.

In the region $\pi = 0$–10 dynes/cm., where the above equations can be accurately applied, the films are perfectly gaseous and obey an equation of state

$$\pi A = kT.$$

Studies on insoluble monolayers[1] and some adsorbed films[2] show that for π greater than 15 dynes/cm. many films obey a modified form of the above equation, namely:

$$\pi(A - A_0) = xkT,$$

where A_0 is the co-area of the molecule (generally less than its cross-sectional area) and x is a measure of the lateral adhesion of the molecules in the film, being unity when there is no adhesion and decreasing as the adhesion increases. Substituting this equation of state into equation (2):

$$\frac{d\ln c}{d\pi} = \frac{A_0}{kT} + \frac{x}{\pi}.$$

Integrating, assuming A_0 and x constant,

$$\ln c = \frac{A_0}{kT}\cdot\pi + x\ln\pi + D, \qquad (3)$$

where D is the integration constant.

Kemball and Rideal[3] put $x = 1$ in this equation, when a direct test of its validity is simple. When x is unknown, equation (3) is not readily applied to the experimental results.

In the gaseous region, equation (3) becomes

$$\ln c = \ln\pi + D, \qquad (4)$$

that is, $c = \pi\beta$.

Subtracting (4) from (3) at corresponding concentrations,

$$0 = \frac{A_0}{kT}\pi + x\ln\pi - \ln\pi', \qquad (5)$$

where π is the measured pressure of the film and π' the pressure the film would have if it were perfectly gaseous. This equation is similar to the one used by Ward and Tordai[4] to calculate surface activities.

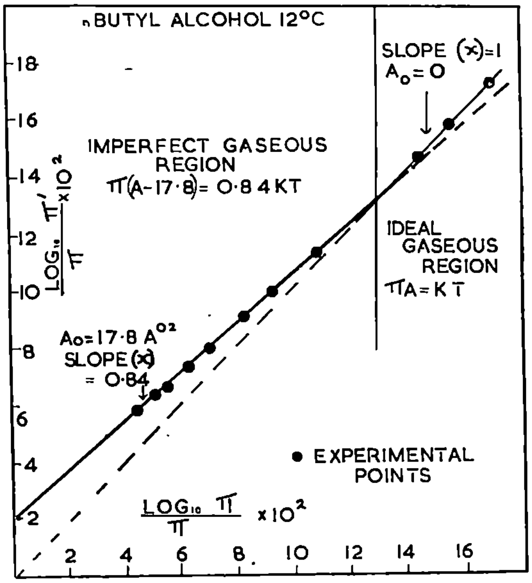

Fig. 1

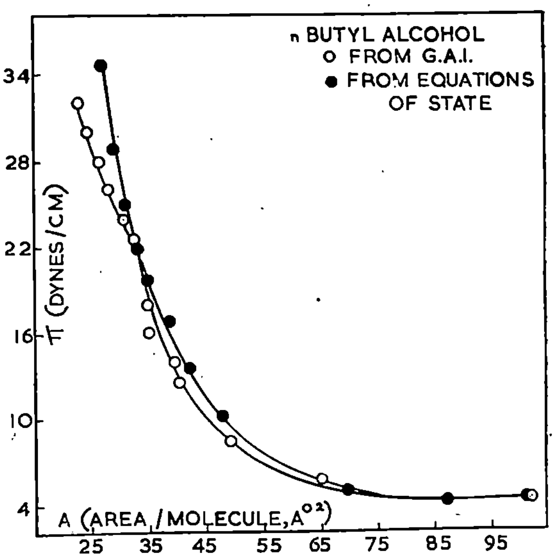

Fig. 2

Equation 5 can be rewritten as

$$\frac{\ln\pi'}{\pi} = \frac{A_0}{kT} + x\frac{\ln\pi}{\pi}.$$

Hence the plot of $\frac{\log_{10}\pi'}{\pi}$ (that is, $\frac{\log_{10}c/\beta}{\pi}$, β being obtained from the initial linear portion of the $\pi \sim c$ curve) against $\frac{\log_{10}\pi}{\pi}$ should be a straight line of slope x and intercept on the $\frac{\log_{10}\pi'}{\pi}$ axis of $A_0/2{\cdot}3\,kT$.

Fig. 1 shows such a plot for *n*-butyl alcohol at 12° C. The line has a slope of 0·84 and an intercept which gives a value of $A_0 = 17{\cdot}8$ A.². Values of x and A_0 were determined for a homologous series of normal aliphatic alcohols: x was found to decrease with increasing chain-length and A_0 to be independent of it.

For values of $\log_{10}\pi/\pi$ greater than 0·1 (π less than 10), the line coincides with that representing a gaseous film which has a slope of unity and intercept zero. When x is much less than unity, that is, the film is more condensed than the above one of *n*-butyl alcohol, the transition is much sharper than that shown in Fig. 1.

Fig. 2 compares the $\pi \sim A$ curve of *n*-butyl alcohol at 25° C. obtained from the equations of state

$$\pi A = kT \text{ (0–10 dynes/cm.)}$$
$$\text{and } \pi(A - 17{\cdot}5) = 0{\cdot}88\,kT \text{ (15–34 dynes/cm.)}$$

with that obtained by direct application of the Gibbs adsorption isotherm.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effects of Radio-Frequency Voltages on Bacteria

NYROP[1], and Brown, Hoyler and Bierwith[2], have claimed that it is possible to destroy a large proportion of the bacteria in a liquid suspension at sub-lethal temperatures by the application of high radio-frequency voltage gradients. Attempts have been made to confirm these results in order to determine the factors involved.

Suspensions of *Bacterium coli* have been treated in a cell consisting of a section of glass tube, 2 cm. long and 0·9 cm. internal diameter, with a platinum electrode closing each end. The suspension was introduced and withdrawn through a small hole on the centre line of the cell. To minimize heating, dilute electrolyte such as 0·0005 *M* phosphate buffer or physiological saline diluted 1 : 100 has been used as the suspension medium. Voltages of up to 1,700 at a frequency of 30 Mc./s. have been applied to the cell.

To avoid purely thermal kills, it was thought desirable for the temperature of the suspension never to exceed 50° C. as a result of the treatment. Measurement of the temperature was soon found difficult, since the presence of a thermocouple during treatment caused local heating. Tests in which the couple was only introduced after the treatment period still showed wide variations in temperature caused by non-uniform heating.

These difficulties have been overcome by the use of a temperature-sensitive compound, silver tetraiodomercuriate (Ag_2HgI_4), which changes colour reversibly from canary-yellow to red at 49° C. This compound is insoluble ; but when in a finely divided form it can be suspended in the electrolyte by agitation. It has not been used in bacterial suspensions but in separate control experiments, and it raises the conductivity of the electrolyte by about the same amount as that resulting from the addition of bacteria.

Using this compound, the occurrence of non-uniform heating in the cell can be clearly demonstrated. The points at which maximum heating is obtained are always the same, although the degree of non-uniformity increases with increasing field strengths. At high values of the order of 850 volts/cm. conditions are such that, although a temperature of 50° C. is reached at points, the maximum temperature that can be measured in the suspension by thermocouple immediately after treatment is 36–40° C. The treatment time corresponding to these conditions is 0·5 sec.

The effect on the bacteria of treatment with radio-frequency voltages has been determined both by plate counts and by the increase in the turbidity of a broth inoculated with the test suspension, as measured photo-electrically. If the time of treatment is limited to that for which a temperature of 50° C. is not exceeded at any point, no lethal effect is found. Only when the treatment time is 50 per cent longer than this is any effect observed. It seems likely, therefore, that this effect is purely thermal.

The lethal effects reported by Nyrop and by Brown, Hoyler and Bierwith may have been due to highly localized heating of the kind detected by the temperature-sensitive compound in our experiments. Since the results of Nyrop and of Brown *et al.* were obtained after a series of pulses of voltage had been applied, it is possible that during the pulse periods there were considerable temperature variations which disappeared due to conduction and convection during the quiescent periods and so were not detected.

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A Photo-electric Method for Measuring Circular Dichroism

A RAY of plane polarized light, on entering an optically active medium, is resolved into two circularly polarized rays (one right-handed and the other left-handed) which travel at different speeds[1]. Cotton[2] found that, in solutions of potassium chromium tartrate, the circularly polarized rays are unequally absorbed, and the emergent light is elliptically polarized. He called the phenomenon 'circular dichroism', and studied it in two ways : (1) by direct experiments with circularly polarized light, and (2) by ellipticity measurements. Later workers, however, have confined their attention almost entirely to the second method. Ellipticity is now usually measured by means of a $\lambda/4$ plate (or Fresnel rhomb) mounted behind the polarizing system of a polarimeter, and with this simple apparatus many substances have been shown to exhibit circular dichroism.

Bruhat[3] was the first to express ellipticity in absorption units. If ε_l and ε_r are the molecular extinction coefficients for left- and right-handed light, respectively, and τ is the ellipticity (in radians), then for a solution containing c gm. mol. per litre in a tube l cm. long, $\varepsilon_l - \varepsilon_r = (4\tau \times 0{\cdot}4343)/lc$. When ε_l is greater than ε_r, the circular dichroism is taken as positive. Kuhn[4] extended ellipticity measurements into the ultra-violet, and introduced the term 'anisotropy factor' (g) for the ratio $(\varepsilon_l - \varepsilon_r)/\varepsilon$, which is important in asymmetric photochemical work[5]. In the middle of an absorption band, g has a maximum value (g_0) which is between 0·02 and 0·10 for most of the compounds studied. When $\varepsilon_l - \varepsilon_r$ is plotted against wave-length (λ), the points lie approximately on a probability curve the parameters of which can be used for calculating the related rotatory dispersion curve[6]. The procedure is not entirely satisfactory, however, since circular dichroism data are much less accurate than those of rotation. Better methods for measuring circular dichroism are required, and the photo-electric one now described should be useful when g is fairly large.

This method had its origin in a lecture experiment for demonstrating circular dichroism with a solution of caryophyllene nitrosite ($g_0 \simeq -0{\cdot}1$). The apparatus was essentially a photo-electric colorimeter[7] (which contained a Christiansen filter and a Weston photronic cell) with the addition of a large polarizing prism and a suitable $\lambda/4$ plate between the filter and the cell for containing the solution. The experiment was carried out with a 1-cm. layer of caryophyllene nitrosite solution (1 per cent in benzene), the filter being adjusted to transmit light in the region of maximum absorption (λ = 6750 A.). First, the λ/4 plate was oriented to give left-handed light, and the indicator on the galvanometer scale was set to 35 cm. The λ/4 plate was then rotated through 90° (to give right-handed light) and the indicator was seen to move back about 5 cm. When a Zeiss–Winkel monochromator was used instead of the Christiansen filter, satisfactory readings were obtained only in the neighbourhood of 6000 A., so that greater over-all sensitivity was required. This is available in the Unicam spectrophotometer, and the instrument can be readily adapted for investigating circular dichroism.

The only additional apparatus required is an attachment (for producing circularly polarized light) which contains a Glan–Thompson prism and a λ/4 plate, the latter being selected for the required region of the spectrum. In the standard model of the Unicam instrument, there is a tubular opening (which contains a quartz lens) between the cell compartment and the exit slit of the monochromator. A brass tube (for holding the Glan–Thompson prism) is inserted behind the lens, and sufficient of the tube rojects to provide a bearing on which the λ/4 plate older can rotate. A metal plate (shaped to fit into he front of the cell compartment) is soldered to the ube to hold it in position and to carry stops for imiting the rotation of the λ/4 plate holder between + 45° and − 45° from the vertical. The optical omponents are then inserted so that, when the λ/4 late is in the + 45° position, right-handed light is ransmitted. It is also necessary to reduce the length f the cell carrier by about 1·5 cm.

Circular dichroism ($\varepsilon_l - \varepsilon_r$) is measured with the nstrument in the following way. (1) Place the cell ontaining solution in the light beam. (2) Adjust he slit-width to give 100 per cent transmission density = 0) for right-handed light. (3) Rotate the /4 plate through 90°. (4) Take the reading on the ensity scale. This value divided by lc gives $\varepsilon_l - \varepsilon_r$. f this should be negative, then the 100 per cent ransmission setting is made with left-handed light. Afterwards, a lever arrangement was added for otating the λ/4 plate without opening the cell com-artment, but this refinement is not essential.

When circular dichroism is obtained from ellipticity easurements (visual or photographic), accuracy is mited by the necessity of using quite dilute solutions. ith the photo-electric method, much more concen-ated solutions can be employed. A 1 per cent nzene solution of caryophyllene nitrosite in a 2-cm. ll showed a difference in transmission of 30 per nt when left-handed light (λ = 6750) was changed right-handed. This result gives some idea of the agnitudes involved. The method has also the vantages of speed and simplicity of operation.

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May 2.

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Spectrographic Determination of a Major Constituent of a Solution

C. FELDMAN[1,2] has recently described a solution spark technique, wherein the solution under investigation is carried in an upper electrode consisting of a narrow graphite cup which has a porous base permeable to the solution, the lower electrode being a solid graphite rod.

The possibilities of adapting this technique for use with apparatus commonly available in Great Britain have been under examination by us, the aim being the determination of a major constituent—zinc—in solutions containing complementary amounts of copper and zinc.

Using the Hilger medium spectrograph and standard spark source, an analytical curve has been obtained from the line-pair Zn 2502·001/Cu 2544·802 for the range 10–90 per cent zinc, 90–10 per cent copper. A reproducibility test on a sample of Naval brass showed: average of 32 determinations, 36·1 per cent zinc; highest figure, 37·5 per cent, lowest figure, 35·0 per cent; standard deviation, 0·71 per cent—in terms of zinc content, 1·97 per cent.

On low-alloy brasses and solutions of copper and zinc over the range 25–45 per cent zinc, the accuracy of single determinations has been better than ± 2·0 per cent for the seventy-eight results so far obtained. 3·0 mgm. of brass suffices for an analysis in duplicate.

These results would seem to commend the method as having wide potentialities for extending the range of spectrochemical analysis.

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April 4.

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Crystal Structure of Ammonium Bicarbonate and a Possible Relationship with Ammonium Hypophosphate

PRELIMINARY work on the structure of ammonium bicarbonate was done by Mooney[1] in 1932, who reported that the space group was *Pccn*.

We have recently found the positions of the atoms in the structure. Approximate atomic co-ordinates, which may yet be modified slightly as a result of work which is in progress, are given below expressed as fractions of the unit-cell edges taking a centre of symmetry as the origin.

	x	*y*	*z*
C	0·0	0·24	0·16
O	−0·03	0·19	0·03
O	−0·03	0·19	0·28
O	0·06	0·35	0·17
N	0·25	0·01	0·41

These co-ordinates are consistent with the presence of planar CO_3 groups of the usual dimensions lying on either side of the diad axes with their planes inclined slightly to the *bc* plane of the unit cell. The CO_3 groups are joined in strings parallel to [c] by hydrogen bonds forming, as it were, polymeric anions. This is exactly similar to the hydrogen-bonded strings of CO_3 groups found by Zachariasen[2] in sodium bicarbonate; in other respects the structures of sodium and ammonium bicarbonates show minor differences.

In a recent letter by Raistrick and Hobbs[3] in which the structure of the hypophosphate ion was discussed, the space group and unit-cell dimensions of ammonium hypophosphate were reported. The figures are very similar to those given by Mooney for ammonium bicarbonate. The space group in each case is *Pccn*, and the unit-cell dimensions in the two cases are *a,b,c*: 7·26, 11·47, 9·38; and 7·29, 10·79, 8·76 A., respectively.

It is interesting to speculate on the possible relationship between the structures of these two compounds. It seems very likely that $P_2O_6^{4-}$ ions could have an external shape and size nearly the same as the shape and size of a pair of neighbouring CO_3^{2-} ions on either side of a diad axis in ammonium bicarbonate, the configuration being governed in each case by the close packing of six oxygen atoms. If this were so, the similarity in cell sizes and space-group symmetry would make it a reasonable speculation that the two structures were in some respects closely related; possibly the oxygen atoms, the ammonium ion and hydrogen bonds occupy similar positions in the cell. This possibility, which would not be difficult to check by structure work, seems to fit in well with Raistrick's choice of structure for the hypophosphate ion.

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Equivalence of Temperature and Frequency in Dielectric Measurements

One usual method of representing measurements of the complex dielectric constant is by a circular arc. Cole and Cole[1] pointed out that, if the dispersion and absorption of a dielectric could be represented by the empirical formula,

$$\varepsilon^* - \varepsilon_\infty = \frac{\varepsilon_0 - \varepsilon_\infty}{1 + (j\omega\tau_0)^{1-\alpha}}, \tag{1}$$

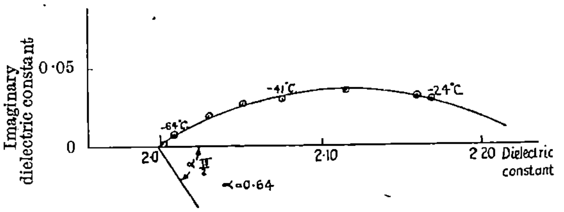
where ε^*, ε_0 and ε_∞ are the complex, static and infinite frequency dielectric constants respectively, τ_0 a generalized relaxation time and $\omega/2\pi$ the frequency of the applied electric field, then the dielectric constant – dielectric loss curve is the arc of a circle the centre of which is displaced below the real axis by an amount depending upon the constant α. If the dipoles in the dielectric are assumed to have a distribution of relaxation times, the distribution can be obtained from α.

This circular arc plot applies to the variation of the complex dielectric constant as a function of the frequency, which is not easy to determine experimentally. It is more usual to vary the temperature than the frequency, and to assume that changes in temperature are equivalent to changes in frequency. This equivalence follows from the theory of a dielectric model having a single relaxation time, but most dielectrics have a wide distribution of relaxation times. Even for these dielectrics, changes in the temperature are assumed to be equivalent to changes in the frequency. An example of this is Sillars's[2] investigation of the dielectric properties of a dilute solution of long-chain esters in paraffin-wax. The dielectric loss – frequency curves were considerably broader than a Debye curve, yet temperature and frequency were related by the equation,

$$\log (1/f_0) = ST_0 + C, \tag{2}$$

where T_0 is the temperature at which the maximum occurs in the dielectric loss curve for a frequency f_0, and S and C are constants.

If temperature and frequency can be interchanged, and if the behaviour of the dielectric is represented by equation (1), then a circular arc plot would also be obtained if the temperature instead of the frequency were the parameter.



Variation of the complex dielectric constant with temperature of a mixture of $C_6H_{13}.CO.C_{11}H_{23}$ and $C_{17}H_{36}$ from −100° C. to −20° C. at 50 kc./s.

This method of analysis was applied to the variation with temperature of the complex dielectric constant of a mixture of a ketone and a paraffin and the result is shown in the accompanying graph The mixture consisted of 28 per cent by weight o the ketone $C_6H_{13}.CO.C_{11}H_{23}$ and 72 per cent by weight of the paraffin $C_{17}H_{36}$. A maximum of 16–1 per cent of the ketone can be dissolved in the paraffi by quenching the mixture from the melt, the remainder of the ketone being precipitated as a separate phase which is dielectrically inert. The result shown in the graph are for the mixture in the supersaturated condition. Measurements were made wit a Schering bridge at 50 c./s., 800 c./s. and 50 kc./ over the temperature range −100° C. to −20 °C. Th same value of α, 0·64, was obtained at all thre frequencies, and therefore only the results obtaine at 50 kc./s. are shown.

A similar analysis of Powles's[3] results for th transition in solid hydrogen bromide, a materi which differs widely from that which I have use also gave a circular arc diagram with temperatu instead of frequency as the parameter. The valu of α was 0·52 at 1 kc./s. as compared with 0·21 − 196·2° C. for the normal circular arc plot.

For both these substances, the locus of the electric constant in the complex plane is a circul arc with the centre of the arc considerably displac below the real axis. This gives, therefore, expe mental evidence for the equivalence of frequency a temperature for a dielectric with a wide distributi of relaxation times. No theoretical explanation this equivalence in the presence of a wide distributi of relaxation times has yet been given.

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Hyperfine Structure and Saturation Effects in the Paramagnetic Resonance Spectrum of Manganese

A MICROWAVE bridge in conjunction with a superheterodyne method of reception has been used for the detection and measurement of weak paramagnetic resonances. It has been possible to investigate, at a frequency of 9,501·5 Mc./sec., the resonance spectrum of Mn++ ions contained, in concentrations down to 1 part in 10^5, as activators in zinc sulphide phosphors.

By means of a 50 c./sec. field modulation the magnetic absorption at room temperature is displayed as a function of magnetic field. For the specimen with a concentration of 1 per cent manganese the resonance absorption curve is similar in shape but narrower (width approximately 300 gauss) than that for hydrated manganese sulphate crystals[1]. A reduction of 'exchange narrowing' may account for the greater overall width of the resonance observed for the next lower concentration of 0·1 per cent manganese. The more interesting feature of the decrease in concentration is, however, the appearance of a hyperfine structure shown by a splitting into six peaks in agreement with the spin of 5/2 for the manganese nucleus. An additional structure is just detectable at this concentration.

The spectrum for the lowest concentration (0·001 per cent Mn) is shown in Fig. 1 and has been examined in more detail by reducing the sweep amplitude and photographing in sections for different static magnetic fields. The complete structure is reproduced diagrammatically in Fig. 2; the magnetic fields corresponding to the individual peaks have been obtained by calibration against proton resonance.

The six main peaks of the complex spectrum are spaced at intervals of 66·2, 66·9, 67·6, 68·3 and 71·5 gauss, corresponding to a hyperfine structure interval of 0·006 cm.$^{-1}$, of the same order as that obtained for copper and cobalt[2,3]. The interpolated centre of this series lies at 3,384·2 ± 0·5 gauss and corresponds to a g factor, after correction for the shift introduced by the hyperfine splitting, of 2(1·0012 ± 0·0002). This figure agrees satisfactorily with the electron spin g value of 2(1·00119 ± 0·00005) obtained by Kusch and Foley[4] from atomic beam experiments. The subsidiary structure of the spectrum results from a second-order splitting of the $^6S_{5/2}$ ground state of Mn++ by the crystalline electric field[5]. In the absence of detailed information on field symmetry and measurements with single crystals, no detailed analysis is possible; but the diagram indicates a possible grouping into five series, corresponding to an initial splitting of the order of 0·002 cm.$^{-1}$.

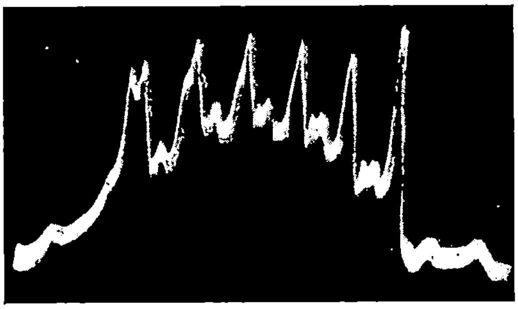

Fig. 1

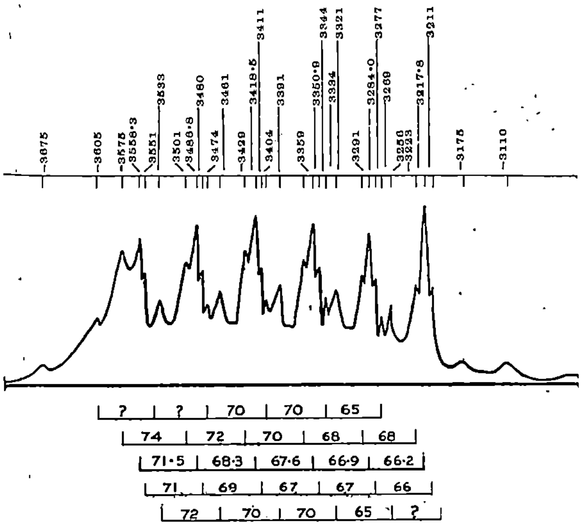

Fig. 2

Experiments at liquid-air temperature, using the phosphor with the lowest manganese concentration, have shown that the general structure of the spectrum is not materially different from that at room temperature, which indicates that the width of the lines is predominantly determined by spin-spin interaction. However, the low-temperature measurements have yielded information on the spin-lattice relaxation. In contrast with the high powers required for investigations on paramagnetic salts[6] the power-level available from the reflex klystron (100 mW.) has been adequate for the study of relaxation effects in the magnetically dilute phosphor. A saturation effect, indicated by a decrease with increasing input of the ratio of magnetically absorbed power to input power, has been clearly established, and from quantitative measurements a value for the spin-lattice relaxation time of 10^{-6} sec. has been obtained.

We are greatly indebted to Dr. G. F. J. Garlick, of the University of Birmingham, for the supply of phosphor specimens.

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Gelation of Montmorillonite

THE combination of optical and elastic studies on sols of Wyoming bentonite containing the smallest particle sizes (15–20 mμ equivalent spherical diameter) have led to the conclusion that the gelation of this system is due to the formation of a fibrillar network in which the plates are aggregated end-to-end in the form of flat, ribbon-like filaments. The growth of these aggregates is indicated in Fig. 1, which shows the increase in the dissymmetry coefficient of the scattered light, and hence an increase in the size

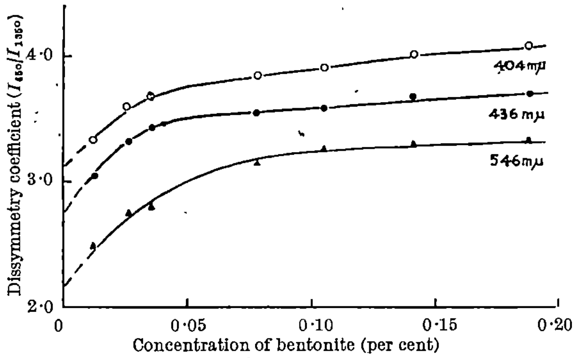

Fig. 1. Variation of the dissymmetry coefficient of the scattered light with particle concentration

of the scattering unit, with increasing particle concentration. The values of the dissymmetry coefficient at infinite dilution correspond to rectangular plates of mean semi-perimeter 300 mμ, while the limiting values of the coefficient at the higher concentrations correspond to long flat filaments of mean width 100 mμ. On account of the irregularity in the particle size and shape, and the probability of incomplete aggregation, these estimates agree as well as can be expected with the mean values of 338 mμ and 150 mμ obtained from electron micrographs of the particles in our sols. The filamentary nature of these aggregates is confirmed by the angular intensity distribution of the scattered light, which fits closely to the theoretical curve.

The spontaneous birefringence which is observed when these sols are placed in cylindrical tubes and annuli is due to a tendency for the aggregates to become orientated perpendicular to the wall.

An investigation of the effect of the addition of uni- and di-valent electrolytes upon the rigidity has enabled us to discriminate, for this system, between the random-mesh[1] and the electrical theories[2] which have been proposed to explain the gelation of a lyophobic sol. According to the random-mesh (or contact) theory, the addition of an indifferent electrolyte should have little effect; whereas on the electrical theory, the rapid compression of the electrical double layer should result in a marked increase in the rigidity. The effect of the addition of sodium hydroxide is shown in Fig. 2; after the addition of about 50 millimoles per litre, preferential adsorption of ions ceases, and the fact that the rigidity increases most rapidly in the later stages is strong evidence for the electrical theory. The subsequent decrease in slope at about 180 millimoles per litre is due to the onset of irreversible flocculation, which is characterized by the appearance of a sudden opacity and 'stickiness' in the previously clear gel.

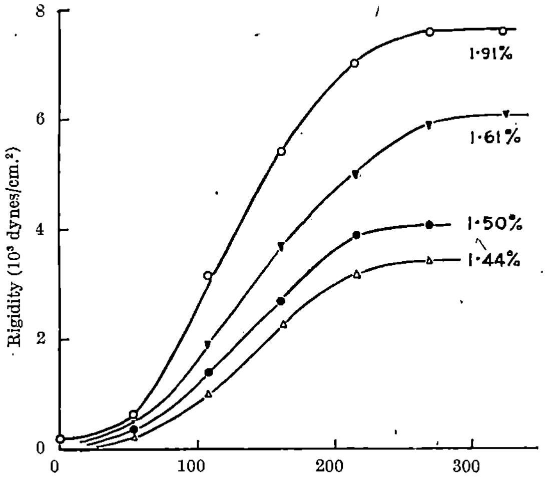

Fig. 2. Effect of univalent electrolyte upon the rigidity of bentonite sols of different concentrations

Taking as the elastic model a network of particles aggregated end-to-end, it can be shown that, for small strains, the rigidity is given by the expression $G = f(N,\alpha)\ d^2V/dx^2$, where V is the total potential energy of two particles situated a distance $2x$ apart and $f(N,\alpha)$ is a function depending upon the angular distribution of the filaments about the normal to the plane of shear. From potential-energy curves constructed on the basis of the recent theory of Verwey and Overbeek[3], the variation of the second differential coefficient at the potential minimum with increasing electrolyte concentration has been determined and the above expression verified experimentally.

We are indebted to Geochemical Laboratories for the gift of the Wyoming bentonite used in this work, a complete account of which will be given elsewhere.

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Iron Intake and Hæmochromatosis in the Bantu

THE high incidence of hæmochromatosis among the Bantu was initially pointed out by Strachan[1], anc has been confirmed by the Gillmans[2,3], who regarc the disorder as one of the manifestations of chroni- malnutrition.

In a recently published paper, Kinney, Hegste- and Finch[4] have reported, *inter alia*, that: (*a*) whe rats were fed on an adequate diet together with 2 pe cent iron citrate, no deposition of hæmosideri occurred in the liver; (*b*) when a diet of 80 per cer corn grits and 20 per cent lard was used, thei was slight deposition of hæmosiderin in that organ (*c*) but when this latter diet was supplemente with 2 per cent iron citrate, massive depositio resulted. Only, therefore, when the diet was inad- quate in many respects and also contained adde iron was the accumulation of this element : the liver observed. The general pattern of the di- tribution of iron in the tissues of the rats was stat- to be similar to that observed in the Bantu subject Since the diet of the Bantu usually contains a lar amount of maize, the above considerations ha prompted inquiry as to the level of the daily ir intake of these people. The purpose of this commu- cation is to provide evidence that an unusually lar amount of iron is, in fact, frequently ingested in th food.

It has been stated that the diet of the African is not particularly rich in iron[3]; but a daily diet including maize to provide, say, 2,000 calories contains 15–30 mgm. iron, thus probably more than covering the generally recommended allowance of 10–15 mgm.[5]. The intake of this element, however, is greatly increased during the preparation of food for consumption, for the Bantu, both in rural and urban areas, very frequently use iron pots for cooking purposes. It has been found that in the cooking of whole maize, maize meal porridge, various types of legumes, and in the preparation of kaffir beer and fermented porridge or 'marewa', the iron content may be increased up to at least five times that contained in the original foodstuffs. A typical diet cooked in the traditional manner may contain 100–150 mgm. iron per diem. When large numbers of Bantu are fed in a communal manner, large iron cooking vessels are also used. Analyses for iron content of the adequate diets consumed have been undertaken at certain centres : the daily food ration of the Bantu workers on the gold mines and at this Institute has given values of 100–150 mgm. iron per diem ; while values of about 100 mgm. per diem have been obtained in the food intake of Bantu prisoners at the Johannesburg Gaol.

Confirmation of the large amounts of iron being ingested by these people has been obtained by determining the iron content of their fæces. In the case of the gold mine Bantus (three-day periods) and the Institute Bantus (one-day periods), the amounts of iron voided varied from 75 to 145 mgm. per diem ; for the gaol Bantus (seven-day periods), the amounts varied from 65 to 105 mgm. per diem. Far less accurate but confirmatory evidence has been obtained by determining, with suitable precautions, the iron content of stools of rural Bantu collected at kraals in the countryside near Johannesburg ; values from 40 to 215 mgm. per stool were obtained. Urines, collected for 24-hour periods, from subjects at the above centres, all contained less than 0·7 mgm. iron per diem. Balance experiments for weekly periods have been carried out on the Bantu prisoners at the gaol, when consuming their everyday food ; since, however, the homogenization of food before consumption was not carried out, the iron-intake figures, and hence the iron-retention figures, are not reliable.

It is obvious from experiments both on animals and man that a high intake of iron is not the cause of hæmochromatosis. Nevertheless, the study of Kinney *et al.*[4] showed that, in the unsatisfactory dietary setting used, such an intake was of critical mportance in promoting the development of the disorder. It is therefore suggested that with the particular type of malnutrition affecting the Bantu, he relatively large amount of iron habitually inested may be an etiological factor in the hæmohromatosis reported to be so common among them.

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Keratins in Invertebrates

IF the term 'keratin' were applied only to those proteins which contain a high proportion of cystine, which give a keratin-type of X-ray diffraction photograph and which dissolve with ease only in alkaline solutions of reducing agents, then keratins, so far as is known, are confined to the epidermis and epidermal appendages of vertebrates, and are always intracellular. Other so-called keratins from vertebrate egg capsules[1,2], byssus threads of *Mytilus*[2], etc., though they contain cystine, can be dissolved by solvents other than alkaline reducing agents, do not give a keratin-type of X-ray photograph and are extracellular structures.

A few intracellular protein structures are, however, known to occur in invertebrates, and some of them have been examined to see if they are chemically allied to keratin. No X-ray photographs were obtained, but cystine was tested for histochemically by the method of Chèvremont and Frederic[3]. No cystine could be demonstrated in the central capsule membrane of the radiolarian *Thalassicola*, nor in the rhabdites of the turbellarians *Planaria* and *Dendrocœlum*. In the nematocysts of the cœlenterate *Corynactis viridis* and in the epidermal supporting fibres of the echinoderm *Asterias rubens*[4], it was possible to demonstrate the presence of cystine, and the nemocysts were dissolved only by alkaline sodium sulphide solution. While this evidence does not prove that the structures are composed of keratin, it suggests that they might be. These results are of further interest because of the suggested evolution of the vertebrates from an echinoderm stock.

This work was carried out at the Zoological Laboratory, Cambridge, and Stazione Zoologica, Naples.

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Enzymatic Synthesis of Citrate from Pyruvate and Oxalacetate

SOLUBLE enzyme preparations from *Escherichia coli* and *Streptococcus fæcalis* catalyse the dismutation of two molecules of pyruvate to acetyl phosphate, lactate and carbon dioxide when orthophosphate is present. Acetyl phosphate was determined by Lipmann's hydroxylamine reaction[1]. The system is almost inactive in the absence of added diphosphopyridine nucleotide (DPN). Maximum reaction-rates require, in addition to enzyme, substrate and pyridine nucleotide, the following components : orthophosphate, magnesium ions (Mg^{++}) or manganese ions (Mn^{++}), diphosphothiamine, a boiled extract of yeast, and lactic dehydrogenase. Coenzyme *A* is required for maximum yields of acetyl phosphate. The nature of the active factor in yeast extract is unknown ; but it is not coenzyme *A*. It is possible that the compound may be a coenzyme form of the factor of O'Kane and

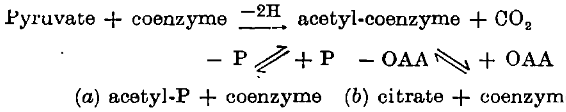
Gunsalus[2] required for oxidative decarboxylation of pyruvate by *S. fæcalis* cells. In the absence of orthophosphate, the reaction-rate is sharply reduced and no acetyl phosphate accumulates. The dismutation can be formulated as follows :

(1) Pyruvate + phosphate + $DPN_{ox} \rightarrow$ acetyl phosphate + CO_2 + DPN_{red}
(2) Pyruvate + $DPN_{red} \rightarrow$ lactate + DPN_{ox} (*lactic dehydrogenase*)

Sum : 2 Pyruvate + phosphate → acetyl phosphate + CO_2 + lactate.

Reaction 1 is an over-all reaction which may involve at least two enzymes. There is no evidence that pyridine nucleotide is the primary hydrogen acceptor.

The primary dehydrogenation reaction may result in the formation of an acetyl-enzyme or acetyl-coenzyme intermediate which, in the presence of another enzyme, may be cleaved either (*a*) by phosphate with formation of acetyl phosphate, or (*b*) by oxalacetate with formation of citrate as indicated in the accompanying scheme. The hypothetical coenzyme may be coenzyme *A*. Reaction (*a*) is probably catalysed by Stadtman's transacetylase[3], reaction (*b*) by the condensing enzyme[4]. This formulation is supported by the finding that both *E. coli* and *S. fæcalis* extracts form citrate at a good rate *in the almost complete absence of orthophosphate*, provided the pyruvate dismutation system is supplemented with oxalacetate and condensing enzyme. Typical results are shown in the accompanying table.



$$\text{Pyruvate} + \text{coenzyme} \xrightarrow{-2H} \text{acetyl-coenzyme} + CO_2$$
$$-P \rightleftharpoons +P \qquad -OAA \rightleftharpoons +OAA$$
$$(a)\ \text{acetyl-P} + \text{coenzyme} \qquad (b)\ \text{citrate} + \text{coenzyme}$$

Bacterial enzyme	System	A: Micromoles of citrate formed per ml.				B: Micromoles formed per ml. in 40 min.	
		5 min.	10 min.	20 min.	40 min.	CO_2	Acetyl phosphate
E. coli (6 mgm. of protein)	Complete		0·61	1·42	3·02	2·9	1·62
	No phosphate*		0·64	1·51	3·38	0·6	~0·1
	No phosphate, no coenzyme *A*		0·16	0·34	0·58		
	No phosphate, no DPN				0·09		
	No DPN					0·2	~0·1
	No condensing enzyme				1·06		
S. fæcalis (7 mgm. of protein)	Complete	0·47	0·88	1·82	3·34		3·2
	No phosphate†	0·66	1·21	2·30	4·65		0·3
	No phosphate, no DPN				1·35		
	No DPN						1·0
	No condensing enzyme				0		

* Orthophosphate present in reaction mixture, 0·06 micromoles per ml.

† Orthophosphate present in reaction mixture, 0·08 micromoles per ml.

(*A*) The complete system contained per ml. : potassium phosphate buffer *p*H 7·4, 50 micromoles ; sodium bicarbonate, 20 micromoles ; L-cysteine, 10 micromoles ; magnesium chloride, 2·4 micromoles ; manganese chloride, 1·6 micromoles ; coenzyme *A*, 5 units ; DPN, 100 γ ; cocarboxylase, 50 γ ; pyruvate, 50 micromoles ; oxalacetate, 20 micromoles ; crystalline condensing enzyme, 50 γ. Gas phase, 5 per cent carbon dioxide and 95 per cent nitrogen ; temperature, 25°.

(*B*) Same as *A*, except for omission of oxalacetate, condensing enzyme and bicarbonate in all samples, and addition of 20 micromoles of *tris* (hydroxymethyl) amino methane buffer *p*H 7·4 in samples without added orthophosphate. Gas phase, nitrogen ; temperature, 25°.

Bacterial enzymes : Lyophilized *E. coli* (4157) ground with an equal weight of Alumina *A* 301, -325 mesh (Aluminium Co. of America) and extracted with 10 volumes of 0·9 per cent potassium chloride containing 0·01 *M* L-cysteine. Mixture centrifuged at 13,000 r.p.m. and 0° for 30 min. and supernatant dialysed 48 hr. at 2° against 0·9 per cent potassium chloride containing 0·005 *M* L-cysteine. *Streptococcus fæcalis* (10C1) acetone powder extracted as *E. coli* and dialysed for 24 hr.

It will be noticed that while the *E. coli* extract used contained limiting amounts of condensing enzyme, the *S. fæcalis* preparations were completely devoid of it. It is significant that orthophosphate produced a small but definite inhibition of citrate synthesis, which was probably due to competition between reactions (*a*) and (*b*). The *S. fæcalis* extracts contain a very active enzyme system catalysing the conversion of two molecules of pyruvate to one of acetylmethylcarbinol and two of carbon dioxide[5]. For this reason the production of carbon dioxide is not a measure of the dismutation alone in this case and has been omitted from the table.

Our results explain the observation that pyruvate is not removed aerobically in dialysed heart homogenates unless a dicarboxylic acid (which can be oxidized to oxalacetate) is present[6]. If the heart preparations do not contain enzyme (*a*), there can be no disappearance of pyruvate, even in the presence of orthophosphate, unless oxalacetate is available. Heart and other animal tissues do not contain transacetylase; but they contain large amounts of condensing enzyme.

We wish to thank Miss Alice del Campillo and Mr. Tibor Farkas for assistance. We are greatly indebted to Dr. W. F. Verwey, Medical Research Division, Sharp and Dohme, Inc., for a generous supply of lyophilized *E. coli* cells. The work was supported by grants from the United States Public Health Service, the American Cancer Society (recommended by the Committee on Growth of the National Research Council), the Office of Naval Research, and the Rockefeller Foundation.

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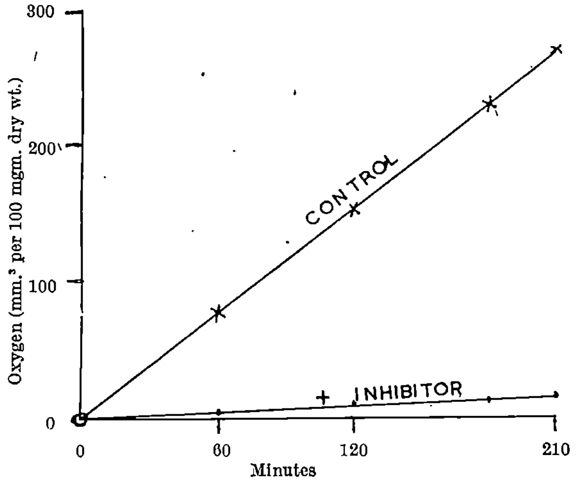
A Germination Inhibitor from Sugar Beet

Tolman and Stout[1] conclusively demonstrated the presence of water-soluble substances in the seed coat of sugar beet, which inhibited its germination. Later[2], they claimed that the toxic action of the water-extract of the beet seed cluster was due to a hydrolytic enzyme, which liberated free ammonia in toxic quantities from nitrogenous substances present in the water extract. Dutch workers[3] claimed that the inhibition of germination was due to the osmotic pressure exerted by inorganic substances present in the seed coat. They could obtain no ether-extractable substance which inhibited germination.



Using peroxide-free 'Analar' ether, thrice distilled in all-glass apparatus, we have obtained from the water-extract of beet seeds an unsaturated yellow oil, which acts as a powerful germination inhibitor when tested on cress (*Lepidium sativum*) and other seeds. The inhibitor seems to exert a specific influence on seedlings, its effect being most marked on the radicle (see table).

Ether extract (p.p.m.)	Hypocotyl fresh wt. per 100 seeds (gm.)	Radicle fresh wt. per 100 seeds (gm.)	Total wt. of seedlings (gm.)	% Germination after 6 days	Ratio radicle/hypocotyl
100	0·396	0·126	0·522	82	0·31
50	0·619	0·170	0·789	90	0·26
10	0·735	0·277	1·012	100	0·37
Control	0·793	0·391	1·184	100	0·49

In attempting to elucidate the physiological action of the inhibitor, respiration studies were carried out on hand-cut sections of sugar beet in a Warburg apparatus. Using fourteen disks of 1 cm. diameter per vessel suspended in 2·5 ml. *p*H 5·5 Sorensen's phosphate buffer and potassium hydroxide in the centre cup, results were obtained as expressed in the accompanying graph.

The inhibitor markedly affects the rate of oxidation of catechol by the polyphenolase enzyme of sugar beet. It apparently does not affect other enzyme systems. Inhibition of the cress seedlings can be reversed by washing, and they then germinate very rapidly. It is thought, therefore, that glycolytic eactions continue in the inhibited seed, so that, when the inhibitor is removed by washing, abundant nergy becomes available for growth.

This work will be published in full elsewhere. We wish to thank the Carnegie Research Fund for a rant in aid for apparatus.

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Effect of D-Tubocurarine Chloride and Carbaminoylcholine on the Respiration of *Daphnia*

Measurements of the respiration of *Daphnia* were made by a modification of the Cartesian diver micromanometer[1]. With D-tubocurarine chloride, decrease of respiration and movement begins in a concentration of 2 mgm./100 ml. At 25 mgm./100 ml. paralysis is complete and respiration diminished by 32 per cent; increasing the concentration to 150 mgm./100 ml. produces no further inhibition of respiration. Thus it appears that the diminution of respiration is due to the loss of muscular activity, which accounts for 32 per cent of the total respiration. This proportion is found to be the same in *Daphnia* with normal respiratory-rates ranging from 0·23 to 0·56 c.mm. oxygen/individual/hr.

Carbaminoylcholine increases respiration and movement in a concentration of 0·01 mgm./100 ml. The increase of respiration reaches a maximum of 190 per cent normal between the concentrations of 1 and 10 mgm./100 ml., when movement is considerably increased. Higher concentrations produce smaller increases of respiration and partial paralysis.

The results with D-tubocurarine show that, in normal *Daphnia*, the oxygen consumption associated with muscular activity bears the proportion 32 : 68 to oxygen otherwise consumed. If the maximum increase to 190 per cent normal, produced by carbaminoylcholine, is due to increased muscular activity, this proportion becomes 122 : 68. It is therefore concluded that, when exerting its maximum effect on respiration, carbaminoylcholine increases by approximately four times the oxygen consumed in association with muscular activity.

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Distribution of the Protective Factors for Vitamin C in Fractions of Liver Homogenates of the Rat

It has been reported by de Caro and Giani[1], Mawson[2] and Giri and Shouri[3] that animal tissue extracts contain factors which protect vitamin C against oxidation. These protective factors were found to be of the nature of thiols[1]. Mawson observed that liver extracts from which glutathione was removed by prolonged dialysis retained the protective properties of fresh extract and concluded that glutathione is not the only constituent responsible for the protective mechanism existing in animal tissues. Later, Giri and co-workers[4] reported that certain purines such as xanthine, uric acid, adenine, guanin, theophylline and nucleic acids exert a protective action on vitamin C against oxidation. Since purines and nucleic acids are widely distributed in cells, it seemed of interest to find out the distribution of the protective factors for vitamin C in various fractions of liver homogenates, in the hope of gaining an insight into the nature of the factors responsible for the protective action.

Rat liver was homogenized with about two volumes of ice-cold hypertonic sucrose solution by means of a Potter–Elvehjem homogenizer, and the fractionation was carried out by the technique described by Hogeboom *et al.*[5], which involves fragmentation of the cell and differential centrifugation. All the fractions were made up to the same volume as the original homogenate (10 c.c.), except the unfractionated residue, which was made up to 20 c.c., and 1 c.c. of each of the fractions and 2 c.c. of the residual fraction were added to the reaction mixture containing vitamin C (10 mgm.) and phosphate buffer $M/45$ (*p*H 7·4). The protective effect of each of the fractions was determined by incubating the reaction mixtures at 37° C. and estimating the vitamin at known intervals of time by titration with the indophenol reagent.

In the accompanying table are given the results of a typical experiment.

INHIBITION OF THE OXIDATION OF VITAMIN C AT *p*H 7·4 BY THE VARIOUS FRACTIONS OF LIVER HOMOGENATES OF THE RAT

Liver fraction	Vitamin C (mgm.) after				
	0 hr.	1 hr.	2 hr.	4 hr.	20 hr.
Vitamin C alone (control)	10·0	6·3	3·6	0	0
Vitamin C + original homogenate	10·0	9·8	9·2	8·1	3·4
Vitamin C + nuclear fraction	10·0	9·8	9·2	8·1	2·7
Vitamin C + mitachondrial fraction	10·0	10·0	9·8	9·7	6·1
Vitamin C + unfractionated residue	10·0	10·0	9·8	9·7	7·3

The results show that all the fractions of liver homogenate inhibit the oxidation of the vitamin, the protective action exerted by the mitachondrial fraction and the unfractionated residue being somewhat more than that exerted by the original homogenate and the nuclear fractions. This suggests that the homogenate contains also factors which oxidize the vitamin, and that these oxidative factors are mostly present in the nuclear fraction. Further work on the nature of these factors and the mechanism responsible for their protective action is in progress.

I acknowledge the kindness of Prof. Hans von Euler for making available the facilities of this Institute for carrying out these investigations.

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Anaerobic Subcutaneous Emphysema of Poultry

IN poultry and pigeons, subcutaneous emphysema is known as a disorder caused by air escaping from the respiratory system (air sacs, lungs and trachea). In such cases, the escaped air accumulates in the subcutis and inflates the skin. This condition can be improved by repeated puncturing of the skin and by expressing the air.

During 1949 and the beginning of 1950, many cases of emphysema with very marked 'ballooning' were received at this Laboratory. The condition could not be corrected by repeated puncturing of the skin. Post-mortem examination of these cases revealed changes in the subcutis and muscles, which closely resembled those encountered in infections caused by anaerobes. Indeed, bacteriological and microscopical examinations proved that this disorder was caused by a mixed infection of *Clostridia* and cocci.

Very little is known, and less even published, about clostridial infection in poultry. Most references deal with single and accidental cases and not with a disease of widespread occurrence. According to our observations, the disease in southern Israel usually appears in the form of a few sporadic cases on different farms, and involves several areas.

In all cases only young birds aged four to sixteen weeks were affected, and *Clostridium welchi*, accompanied sometimes by *C. tertium*, was isolated. In most of the fowls thus affected, the disease terminated in death. We believe that infection occurs through skin wounds.

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Direct Isolation of D-Deoxyribose by Mercaptanolysis of Calf Thymus Deoxyribonucleic Acid

THE identity of 2-deoxyribose as a carbohydrate constituent of thymus nucleic acid was demonstrated by Levene. Using acidic hydrolysis[1] and enzymic methods[2], it was possible to prove that 2-deoxyribose was combined with the purine residues in the nucleic acid, though the nature of the sugar combined with the pyrimidine moiety is still uncertain[3].

The problem has now been re-investigated in the light of recent developments. Stacey *et al.*[4], working with sperm nucleic acid, found that the substance is very sensitive to acidic reagents, and there was evidence that at least some of the sugar units may possess highly labile aldehydo linkages, and that methyl acetal-like substances are formed when the nucleic acid is degraded by methanolic hydrogen chloride. It has now been found that calf thymus nucleic acid behaves in a similar manner toward acidic reagents, and it appeared worth while to attempt the isolation of a deoxy sugar component as a crystalline derivative of the aldehydo form. Experiments were carried out on fibrous calf thymus nucleic acid provided by the courtesy of the late Prof. J. M. Gulland. Since the dibenzylmercaptal of 2-deoxyribose is stable under acid conditions[5], concurrent hydrolysis and mercaptylation were carried out with aqueous hydrochloric acid and toluene-ω-thiol at − 5° C. (or with toluene-ω-thiol saturated with hydrogen chloride) in the following manner. The nucleic acid (0·5 gm.) was finely dispersed and stirred with toluene-ω-thiol (0·5 c.c.) at − 5° C. Strong hydrochloric acid (0·5 c.c., density 1·1) was slowly added, with vigorous stirring, to the mixture. The nucleic acid appeared to swell and then to assume a white gum-like form. After four hours, the reagents were separated from the mercaptylated product, which was then washed alternately with water, acetone and ether to remove excess reagents. The solid was treated with ammonium hydroxide (5 c.c., 5 N) at room temperature for 30 min. and then evaporated to dryness, under diminished pressure, at room temperature. The product was extracted with dry ether. Evaporation of the ether extract yielded a crystalline solid (53 mgm.) which was recrystallized from ether–ligroin: $[\alpha]^{23}_D + 12 \cdot 8°$ (in chloroform, *c.* 0·47); melting point 66–67° C. alone or in admixture with an authentic specimen of 2-D-deoxyribosedibenzylmercaptal[5] (found: C, 62·1; H, 6·6; S, 17·1 per cent; calc. for $C_{19}H_{34}O_3S_2$, C, 62·6; H, 6·7; S, 17·6 per cent). The identity of this derivative was further demonstrated by its positive reaction after treatment with a trace of mercuric chloride solution towards the Dische reagent[5,6].

For comparison, D-ribose dibenzylmercaptal was synthesized from D-ribose (presented by Hoffman–La Roche Inc.) by reaction with toluene-ω-thiol and concentrated hydrochloric acid at room temperature. The product, recrystallized from chloroform–ligroin, had melting point 121–123° C., $[\alpha]^{19}_D - 139 \cdot 8°$ (in chloroform, *c.* 0·26); (found: C, 60·1; H, 6·19; S, 16·60 per cent. $C_{19}H_{24}O_4S_2$ requires C, 59·91; H, 6·32; S, 16·85 per cent).

Examination of the insoluble residue showed that it was still a large molecule containing phosphorus and nitrogen, and that benzyl mercaptal groups had entered the molecule. This material gave a positive Dische test and is being investigated further.

I am indebted to Princeton University, New Jersey, for the award of a Rockefeller Foundation Fellowship and to Profs. E. S. Wallis and E. Pacsu for their interest in the work.

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A Factor influencing the Intracellular Exposure of Sulphydryl Groups

IN the course of some experiments involving the ddition of solutions of sulphydryl inhibitors to ultures of *Paramecium bursaria*, it was noticed that wide range of response was obtained from concenrations just below a lethal level. Further examination as shown that the period of survival of any one ulture when exposed to a given concentration of a lphydryl inhibitor is dependent upon the illuminaon of the culture, both immediately before and uring the experiment.

Experimental studies have been undertaken using a standard source of illumination a mercury pour lamp screened with a glass filter opaque to diations of less than 3300 angstroms. The stock lture of *Paramecia* from which all experimental mples were drawn was kept in the dark, and all periments were carried out in a darkened room. aminations of the cultures were made with the d of a low-powered bulb screened with a Wratten *A* filter.

Preliminary experiments showed that regularly eatable results could be obtained with the standlized conditions of illumination. Results obtained th a number of sulphydryl inhibitors are given the accompanying table. The first row gives the times in minutes for the death of 90 per cent of the cells in the culture when maintained in the dark after addition of the sulphydryl inhibitor. The second row is the corresponding figure for cultures irradiated for 15 min. immediately prior to the addition of the inhibitor; these cultures were then kept in the dark. The third row gives the results obtained when the cultures were exposed to the lamp after addition of the inhibitor.

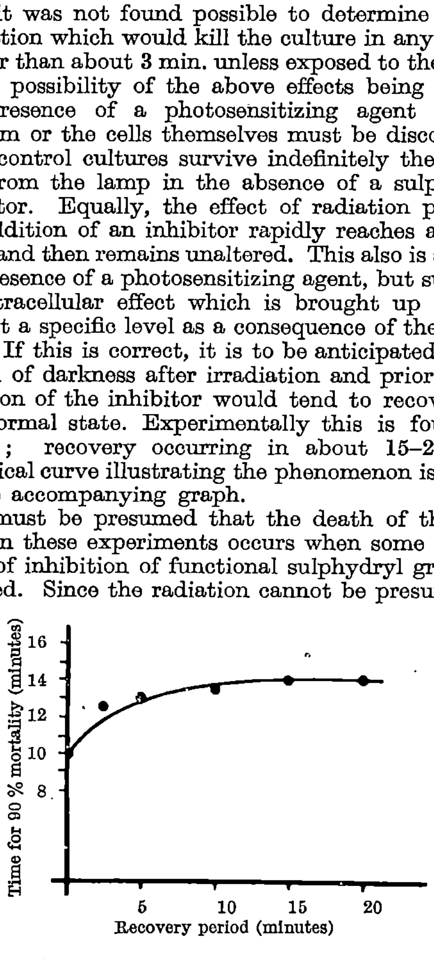
Times, in minutes, for death of 90 per cent of cells under varying conditions. Concentrations are those in final cultures after addition of inhibitor

	Iodo-acetic acid 5×10^{-4}	Iodo-acetic acid $6 \cdot 6 \times 10^{-4}$	Mono-chlor-acetone $3 \cdot 3 \times 10^{-4}$	Maleic acid 5×10^{-4}	Mer-curic chloride 1×10^{-6}	Pro-pion-alde-hyde 5×10^{-4}
In dark	32	23	45	—	14	48
15 min. radiation	30	19	45	—	10	47
Under lamp	14	10½	16	45	6	15

The time-period of 15 min. for irradiation used in the above experiments was arbitrarily chosen after a series of experiments had shown that any effect obtained increased with periods of irradiation of up to 15–20 min.; but that prolongation beyond this had no further effect. In the case of maleic acid, it was not found possible to determine a concentration which would kill the culture in any period greater than about 3 min. unless exposed to the lamp.

The possibility of the above effects being due to the presence of a photosensitizing agent in the medium or the cells themselves must be discounted, since control cultures survive indefinitely the radiation from the lamp in the absence of a sulphydryl inhibitor. Equally, the effect of radiation prior to the addition of an inhibitor rapidly reaches a maximum and then remains unaltered. This also is against the presence of a photosensitizing agent, but suggests an intracellular effect which is brought up to and held at a specific level as a consequence of the radiation. If this is correct, it is to be anticipated that a period of darkness after irradiation and prior to the addition of the inhibitor would tend to recovery to the normal state. Experimentally this is found to be so; recovery occurring in about 15–20 min. A typical curve illustrating the phenomenon is shown in the accompanying graph.

It must be presumed that the death of the cells used in these experiments occurs when some specific level of inhibition of functional sulphydryl groups is reached. Since the radiation cannot be presumed to



Recovery from irradiation. Mercuric chloride: 1×10^{-6} Non-irradiated controls gave, as a mean of six results, 14½ min.

have any influence on the rate of penetration of the inhibitors into the cells, the more rapid occurrence of death under the conditions of irradiation must be due to a greater availability of sulphydryl groups. In other words, radiation with wave-lengths greater than 3300 A. causes an increased exposure of intracellular sulphydryl groups.

This conclusion, together with its obvious corollary, of increased cellular susceptibility to attack through its functional systems dependent upon sulphydryl, may offer an explanation for the well-known avoidance of strong light by such free-living organisms as *Paramecia*. In addition, the above findings are of importance with regard to the mechanism of photodynamic action. This latter point will be discussed in detail elsewhere.

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An Exchange between Free Purines and Pyrimidines and the Aglucones of Deoxyribosyl Purines and Deoxyribosyl Pyrimidines

The ability of a single deoxyriboside to support growth of several species of bacteria has prompted us to investigate the mechanism of deoxyribosidic interconversion in these organisms. An arbitrary system was adopted which consists of two parts: (1) a crude enzyme preparation from one such organism (*Lactobacillus helveticus*); (2) measurement of the quantity of deoxyriboside (synthesized or destroyed) by microbiological assay with another such organism (*Thermobacterium acidophilus* R_{26}). The enzyme preparation contained neither adenine deoxyriboside deaminase nor cytosine deoxyriboside deaminase.

Purine deoxyribosides were differentiated from pyrimidine deoxyribosides by virtue of the resistance of the latter to mild acid-hydrolysis[1]. Individual deoxyribosides were separated by chromatography on paper using *n*-butanol–water–ammonia or *n*-butanol–water–acetic acid systems. Their positions were found under ultra-violet light, and the amounts were determined after cutting out the areas of paper and extracting with water.

By these procedures, it has been possible to demonstrate an exchange of purines and pyrimidines, linked as aglucones to the deoxyribosyl group, with free purines and pyrimidines which are added to the enzyme system. When deoxyribose phosphate[2] is tested in this system, however, with either purines or pyrimidines, no significant synthesis of deoxyribosides takes place. It is therefore concluded that the mechanism of exchange does not involve deoxyribose phosphate as the intermediate.

Thymine, uracil and 5-methyl cytosine (Dr. H. K. Mitchell kindly supplied this compound) have been found to be exchanged with purine deoxyribosides to give pyrimidine deoxyribosides. Chromatography has revealed that the pyrimidine deoxyribosides formed from thymine and uracil have R_F values identical with those of thymine deoxyriboside and uracil deoxyriboside respectively. The latter is of interest, since this is the first occasion upon which a biological role has been reported for this compound.

All the usual purines (except uric acid) and 4-amino-5-imidazole carboxamide (prepared from formylmalonamamidine hydrochloride, which was a gift from Dr. D. W. Woolley) react with pyrimidine deoxyribosides to give products which show the acid lability characteristic of purine deoxyribosides. Except for the fact that the product of the reaction between 4-amino-5-imidazole carboxamide and thymine deoxyriboside is not hypoxanthine deoxyriboside, nothing is known of its nature.

Certain other products have also been examined by chromatography on paper. Adenine is exchanged with uracil deoxyriboside to give adenine deoxyriboside. Xanthine is exchanged with uracil deoxyriboside to give a deoxyriboside having an R_F value of 0·06—a value less than that of any deoxyriboside at present known.

I wish to thank Dr. E. Hoff-Jørgensen and Dr. H. M. Kalckar for the use of their laboratories, and for their inspiration and help. Mrs. A. L. Ziesler gave technical assistance.

This work was supported by grants from Lederle Laboratories Division, American Cyanamid Co., the Rockefeller Foundation, Carlsbergfondet and the Jane Coffin Childs Memorial Fund for Medical Research, the last-named of which had awarded me a fellowship.

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May 6.

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Detection of Sugars on Paper Chromatograms

The ammoniacal silver nitrate spray[1] used for the detection of sugars has several disadvantages; to those mentioned by Partridge[2] should be added the necessity for very careful control of the heating step particularly important in laboratories lacking specia apparatus. We have introduced modifications, based on a test given by Feigl[3] for reducing sugars, which eliminate the heating step, and in which the reagent are applied in organic solvents, thus removing the danger of migration of the sugar spots. The method has been in use for more than a year, and has proved easy to handle and extremely reliable.

In the modified procedure the dried, developed paper chromatogram strip is first passed rapidly through a reagent solution, prepared by diluting 0·1 ml. of saturated aqueous silver nitrate solution to 20 ml. with acetone, and adding water dropwise, with shaking, until the silver nitrate which separates on addition of acetone has redissolved. Spreading o the spots is limited on account of the sparing solubility of sugars in acetone (0·014 per cent at 23° C for crystalline glucose[4]). The dry paper is sprayed with a 0·5 *N* solution of sodium hydroxide in aqueous ethanol, made by diluting saturated aqueous sodium hydroxide solution with ethanol. Brown silver oxide is immediately produced, the colour facilitating eve spraying. Reducing-sugars form dense black spot of silver more or less rapidly at room temperature When reduction is judged complete, excess silve oxide is dissolved by immersing the strip for a few minutes in 6 *N* ammonium hydroxide, after whic the paper is washed for at least one hour in runnin water, and dried in an oven. Black or dark brown spots on a white ground are obtained, except when phenol has been used as the developing agent, when the background is greyish. The spots can be rendered jet black by momentary exposure to hydrogen sulphide. A feature of the method is that substances other than reducing-sugars are detected. Thus glycerol[5] reacts at room temperature after a much longer period of contact with the reagent than is required for reducing-sugars. Under the same conditions, trehalose, a non-reducing disaccharide, reacts faintly ; but the spot can be intensified by heating.

A similar technique for the detection of sugars has been employed, using triphenyltetrazolium chloride which, in alkaline solution, is reduced to the insoluble, intensely red, formazan compound. This property has been used in the analysis of reducing-sugars[6]. A 0·5 per cent solution of triphenyltetrazolium chloride in chloroform is applied as above, and after evaporating the solvent at room temperature, the strip is sprayed with an alcoholic solution of sodium hydroxide. After standing overnight, reducing-sugars develop intense red spots against a pink background, fructose and xylose reacting especially readily. The excess reagent is easily removed by irrigation with water. If rapid reaction is required, the long standing at room temperature may be replaced by five minutes heating at 100° C. in the oven in a moist atmosphere. Non-reducing disaccharides such as sucrose and trehalose do not react.

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Chromatography of Steroids on Alumina-impregnated Filter Paper

THE method described below was developed with he view of detecting and estimating the small mounts of steroids present in the blood and tissues f mammals. It has proved very useful for studying he output of the adrenal gland, and is sufficiently ensitive to be used on small samples of human blood.

Detection of very small amounts of steroid on aper chromatograms presents difficulties, but two ethods have proved very useful. In the first[1], the romatogram is pressed down over Ilford Reflex o. 50 paper and exposed to a flash from an ultra-olet lamp. About 5 μgm. of an αβ-unsaturated eroid suffices to produce a light spot on the photo-aph, but the exposure must be as short as possible. quicker and more sensitive method, which works th all steroids so far tested, is a modification of ante's method for nitrogenous compounds[2]. The romatogram is dipped for a few seconds into a turated solution of iodine in petroleum (60–80°). no spots are seen, the immersion is prolonged. rther increase in sensitivity can be obtained by heating the iodine solution to 40° C. on a water-bath. The sensitivity is markedly decreased by acid and various contaminants in the paper. The chief precautions needed are complete removal of traces of solvents, dryness and neutralization of acid by a short period in ammonia gas. The iodine solution must be kept fresh and fully saturated. In order to make the colours more permanent, the chromatogram can be sprayed with a concentrated starch solution when all background iodine has disappeared. This treatment often shows up previously invisible iodine spots.

This method seems surprisingly sensitive, and the reaction is peculiar in that it seems to depend very little on substituent groups in the steroid nucleus. However, some differences in colour are shown. Most steroids give a yellow colour ; œstrone and œstradiol give a brownish colour ; 11-dehydro-17-hydroxy corticosterone gives a yellow on alkaline, green on neutral and blue on acid papers (cf. Zaffaroni *et al.*[3]) and seems unique in this respect. Cortical extracts and adrenal venous blood extracts yield a very water-soluble fraction giving a red colour. This fraction has been partially split into spots giving orange, grey-green and crimson colours with iodine. Again, most steroids release their iodine completely to give the usual blue starch colour ; but androsterone (and testosterone slightly) tend to give a pink colour with starch after iodine. This method will detect 1 μgm. or less of steroid. A disadvantage is that a large number of non-steroid substances give this reaction[2].

The impregnated paper has been made by soaking Whatman paper No. 54 in a solution of 200 gm./l. ammonium alum at 60° C., hanging the soaked paper for 15 min. in a closed glass vessel, adding a liberal volume of 0·880 ammonia to the vessel and leaving overnight. The paper is then removed and washed in running water for six hours before drying. It seems essential to use a very dense precipitate, and to include the 15-min. hanging period in order to cover the cellulose completely. Otherwise large amounts of steroid remain on the origin of a chromatogram. Thus progesterone on dry untreated filter paper is not moved at all by a flow in benzene ; but on alumina-paper it moves with an R_F of 0·85. Otherwise the method is entirely similar to that of Datta *et al.*[4].

In agreement with Datta *et al.*, the activity of the paper is found to vary very little with the temperature of drying. Two useful methods of varying the activity for steroid work have been found. For lowering the R_F values of phenolic steroids (and less for other steroids) soaking in $N/20$ ammonium hydroxide for four hours can be used. Again the activity can be raised and some separations improved by prolonging the period in running water when the tap water is hard.

Using only 6–9-in. strips, progesterone, œstrone and œstradiol are easily separated (R_F 0·85, 0·4, 0·1) by a benzene flow ; œstrone, testosterone and androsterone are best separated by tetralin ; the acetates of deoxycorticosterone, 11-dehydrocorticosterone, corticosterone, and 17-hydroxycorticosterone are separated by a single flow in benzene (R_F 0·76, 0·4, 0·24, 0·1). Cortical steroids are rapidly destroyed on alumina[5] and 'tail' badly : 21-acetylation prevents these losses, and masks their common 21-hydroxyl group so as to render their differences more apparent on a chromatogram.

Attempts to use other precipitates in paper have given poor results, since most other adsorbents have to be precipitated with aqueous reagents and seem to leave much cellulose uncovered. Further, it seems that so-called 'weak' adsorbents become much more active when precipitated in paper.

This work was done while holding a studentship of the Medical Research Council. I am indebted to Prof. T. Reichstein for samples of pure cortical steroids, to Dr. T. Mann for samples of progesterone and testosterone, and to Prof. C. W. Shoppee, Dr. C. S. Hanes and Dr. P. R. Lewis for much helpful advice.

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Boveri and the Early Days of Genetics

PROF. R. C. PUNNETT's informative and charming account of "Early Days of Genetics"[1] ends with a statement which for the sake of historical justice requires comment. In answer to the question why the discoverers of linkage "managed to miss the tie-up of linkage phenomena with the chromosomes", Punnett says: "The answer is Boveri. We were deeply impressed by his paper 'On the individuality of the chromosomes' and felt that any tampering with them by way of breakage and recombination was forbidden."

Boveri himself, however, not only interpreted the theory of the individuality of chromosomes liberally enough to permit exchanges of chromosome parts but also explicitly predicted the discovery of genetic linkage and crossing over, and provided the now accepted cytological interpretation. In his famous "Ergebnisse über die Konstitution der Chromatischen Substanz des Zellkerns" (Jena, 1904), Boveri summarizes in chapter 1 the theory of the individuality of chromosomes, quoting and enlarging upon his statement of 1887: "I regard the socalled chromatic segments or elements as individuals, I might say as the most elementary organisms which lead their independent existence in the cell." In chapter 5, which deals with meiosis, Boveri discusses the pairing of chromosomes as follows: ". . . that . . . possibly a process is involved which corresponds to the conjugation of unicellular organisms so that if we say that the copulating chromosomes separate again in the the second (or first) maturation division, this should not be regarded as of different meaning than if we say the same of two ex-conjugated Paramecia. They are not any more the same which had conjugated, for they have mutually exchanged certain parts."

The prophetic statement on the cytogenetics of linkage and crossing-over occurs on page 118 in the final chapter; immediately after Boveri's exposition of the chromosomal basis of the Mendelian laws. It is reproduced here in the original German and in translation. The sentences in italics are in roman type in the original. They have been underlined by the late Karl Belar in his copy of the book now in my possession. More than twenty years ago, Belar directed my attention to Boveri's prediction:

If "zwei Merkmale bei fortgesetzter Zucht immer gemeinsam auftreten oder gemeinsam verschwinden, mit grösster Wahrscheinlichkeit den Schluss zu ziehen erlauben, dass die Anlagen für diese beiden Merkmale in dem gleichen Chromosoma lokalisiert sind. *Und weiter: wenn sich eine Bastardierung auf zahlreiche Merkmale erstreckt und sich bei fortgesetzter Zucht ergibt, dass die Zahl der Kombinationen, in welchen die einzelnen Merkmale verbunden sein können, grösser ist als es den Kombinationsmöglichkeiten der vorhandenen Chromosomen entspricht, so wäre daraus zu folgern, dass die in einem Chromosoma lokalisierten Merkmale sich bei der Reduktionsteilung unabhängig voneinander in die eine oder die andere Tochterzelle begeben können, was auf einen Umtausch von Teilen zwischen den homologen Chromosomen hinweisen würde.*" (If "in successive breeding two traits should always appear together or disappear together, then it would be permitted to draw the conclusion, with the highest probability, that the *anlagen* for these two traits are localized in the same chromosome. *And furthermore: if a hybridization experiment included numerous traits and if it should be found in successive breeding that the number of combinations in which the separate traits can occur, is greater than it would correspond to the possibilities of recombination of the chromosomes present then it would have to be concluded that the traits localized in a chromosome can go independently of each other int one or the other daughter cell which would point to an exchange of parts between the homologous chromosomes.*")

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May 20.

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Chromosome Numbers of *Cerastium* Species

THE chromosomes of four species of *Cerastiun* namely, *C. vulgatum*, *C. alpinum* (including *C alpinum lanatum*), *C. arvense* and *C. perfoliatum* have been counted from root-tips of young seedling I give here a list of chromosome counts made b previous workers, none of which is of British materia together with my own counts.

Species	$2n$	Author	Date
C. vulgatum	144	Rohweder[1]	1939
C. ,,	126	Hagerup[2]	1944
C. alpinum	72	Böcher[3]	1944
C. ,,	72	Löve and Löve[4]	1944
C. ,,	108	Sörensen and Westergaard	from Löve and Löve[5]
C. arvense	72	Rohweder[1]	1939
		Original source of material	
C. vulgatum	136	The Weald, Sussex, England	
C. alpinum	72	Auchlean, Inverness-shire, Scotland	
C. alpinum lanatum	72, 108	Not known (from Th. Ingwersen	
C. arvense	38	Oetztal, Tirol, Austria	
C. perfoliatum	38	Not known (from Chelsea Physic Garden)	

The count $2n = 136$ for *C. vulgatum* differs fro counts made with Continental material[1,2]. This speci is very variable, and work is in progress on materi collected from other parts of Britain.

Two different counts for *C. alpinum*, $2n = 72$ and $2n = 108$, have been confirmed. The higher number, $2n = 108$, was found only in one seedling of *C. alpinum lanatum*. Sörensen and Westergaard's count of $2n = 108$ was made from material collected in Greenland. The occasional presence of $2n = 108$ plants among $2n = 72$ material strongly suggests that the $2n = 108$ plants have arisen as a result of chromosome doubling in the $2n = 72$ plants.

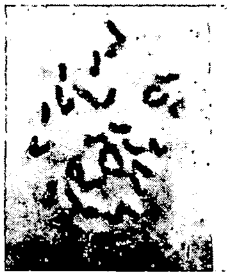

Fig. 1. Somatic metaphase plate of *C. arvense* showing 38 chromosomes. × *c.* 2,000

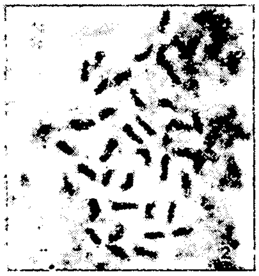

Fig. 2. Somatic metaphase plate of *C. perfoliatum* showing 38 chromosomes. × *c.* 2,000

The two counts of $2n = 38$ for *C. arvense* and *C. perfoliatum* (see figs.) are both new. Rohweder counted $2n = 72$ for *C. arvense*. The number $2n = 38$ has also been counted[1] for *C. tomentosum* and *C. chloræfolium*. It is therefore concluded probable that $19 (2n = 38)$ is the basic number for one section of the genus. This would be an additional basic number for *Cerastium* ; previously 9 has been stated to be the basic number[2]. The species *C. arvense*, a remarkably variable one, appears to include both basic numbers. Further work on British material of *C. arvense* is in progress.

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Sagitta setosa J. Müller in the Clyde

THE Chætognatha of Scottish waters have been scussed by Fraser[1–3]. *Sagitta elegans* Verrill is the minant form, and appears to be found particularly those areas where Atlantic water mixes with astal water. *S. setosa*, except for a few specimens the northern entrance of the Irish Sea (in July), s absent from the north and west coasts of Scotland. ussell[4], in examining collections of Farran, found *setosa* late in the year at the entrance to the North annel of the Irish Sea. Both Fraser and Russell nsider the *S. setosa* of the Irish coast to have ered out from the Irish Sea. Russell considers they y have drifted up through St. George's Channel. rce[5,6] has found *S. setosa* together with *S. elegans* along the English west coast from Morecambe Bay to Anglesey, and considers they are indigenous to that area.

In the Clyde area the form recorded is *S. elegans*, and, although no regular and systematic observations have been made on this group hitherto, the consensus of opinion is that *S. setosa* has never been noted. This is perhaps surprising in view of the comparatively low salinities[7] often observed in this area (mean surface salinity, Keppel Pier, 1949 = 31·88 $^0/_{00}$); since Furnestin[8] has found *S. setosa* in the Gulf of Gascogne where the Gironde estuary lowers the salinity. The occurrence of considerable numbers of this species well inside the Clyde area is therefore of interest. *S. setosa* was first observed in November 1949 in Loch Fyne, a few specimens being taken in both the upper and lower parts of the loch at a depth of 8–10 metres. In December a large catch of *S. setosa* was obtained off the south of Bute.

The latter catches were taken in eight horizontal hauls at 25 metres with small nets (46 cm. diameter), the mean catch per tow of 1 mile being thirty animals. A large proportion (74 per cent) of the animals appeared to be in a moribund condition, and all were immature. In both state of development and size (mean length, 11·6 mm. ; range, 9·2–14·0 mm. ; standard error of mean, ± 0·08 mm.) the catch was homogeneous. Dr. Fraser points out that these *S. setosa* are rather more heavily muscled than those of the North Sea, and resemble a few specimens he recently found in the Minch area. Pierce found that in the Mersey Channel the *S. setosa* reached their maximum numbers in October, and in November the population consisted largely of immature (stage I) individuals (modal length $\simeq$ 12 mm., range 9·0–16·0 mm., values read from the graph).

Proudman[9] has indicated a mean current from south to north through the Irish Sea ; but the general absence of *S. setosa* from the Clyde area suggests that little of the Irish Sea water finds its way into this area ; this is substantiated by the difference in plankton between these areas (Herdman[10]). However, the present observations, particularly the agreement of the measurements with those given by Pierce, together with the records of Russell and Fraser, indicate that in the autumn there is some transport of water from the Irish Sea into the Clyde. It is possible, however, that Irish Sea water is only detected in the Clyde area during the autumn by *S. setosa*, since this species is then at a maximum in the Irish Sea.

Thanks are due to Dr. J. H. Fraser, both for confirming the identity of the specimens and for his critical comments.

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May 17.

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FORTHCOMING EVENT

*(Meeting marked with an asterisk * is open to the public)*

Wednesday, September 13

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. L. W. Cabot, Mr. J. W. Edminster and Mr. C. A. Stokes: "Manufacture of Furnace Carbon Black from Liquid Hydrocarbons at Ellesmere Port".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT AGRICULTURAL ECONOMISTS (with a degree in agriculture or economics)—The Registrar, The University, Manchester 13 (September 15).

ASSISTANT LECTURER or LECTURER IN GENERAL BACTERIOLOGY in the Department of Botany—The Registrar, University College, Cathays Park, Cardiff (September 16).

CHEMISTS in the Executive's Laboratory Service: (1) (Ref. F/EV. 139a) with experience in the investigation of problems other than metallurgical such as arise in the use, maintenance and repair of rolling stock, vehicles, permanent way and buildings; (2) (Ref. F/EV. 139b) with experience of paints and paint testing, together with the investigation of problems arising in connexion with the use of paints and other protective treatments—The Staff Officer, London Transport Executive, 55 Broadway, London, S.W.1, quoting the appropriate Ref. No. (September 16).

LECTURER IN CHEMISTRY, and a LECTURER IN MATHEMATICS—The Registrar, Birmingham Central Technical College, *Suffolk Street*, Birmingham 1 (September 16).

LECTURER IN FUEL TECHNOLOGY—The Registrar, The University, Leeds 2 (September 16).

SENIOR LECTURER IN CHEMISTRY—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 16).

CHEMISTS (with a University degree with first- or second-class honours in chemistry) in the Research Laboratories at Leatherhead—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, *British Electricity House, Great Portland* Street, London, W.1, quoting Ref. AE/83 (September 18).

CARTOGRAPHER (graduate in geography)—The Secretary, The University, Aberdeen (September 20).

NUTRITIONIST in the Department of Health—The Secretary to the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (September 20).

LECTURER IN THE DEPARTMENT OF PHYSICS (with a good degree and, preferably, teaching experience), and a LECTURER (with a good degree in *chemistry and, preferably, teaching* and/or industrial experience) IN THE DEPARTMENT OF CHEMISTRY, Leeds College of Technology—The Chief Education Officer, Education Department, Leeds 1 (September 23).

PHYSIOLOGISTS (male) with wide interests in human applied physiology, as Principal Scientific Officer or Senior Scientific Officer at a Ministry of Supply research unit in Hampshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.235/50 (September 23).

CHEMICAL ENGINEER with research experience to take charge of the Carbonization Section in the Board's Central Research Establishment at Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/246 (September 25).

LECTURER IN FUEL TECHNOLOGY—The Registrar, College of Technology, Manchester 1 (September 25).

PRINCIPAL SCIENTIFIC OFFICER to take charge of the Technical Information Services of a Ministry of Supply Research Establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.244/50A (September 29).

SCIENTIFIC LIBRARIAN (Experimental Officer grade) in a Ministry of Supply Research *Establishment near* London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.245/50A (September 29).

PROFESSOR OF AGRICULTURAL BOTANY (with special reference to Cytogenetics)—The Registrar, University College of Wales, Aberystwyth (September 30).

RESEARCH POST IN EXPERIMENTAL PATHOLOGY—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (September 30).

SENIOR LECTURER IN CIVIL ENGINEERING at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER IN THE SECTION OF METEOROLOGICAL PHYSICS, C.S.I.R.O., Highett, Victoria, to assist in research into the general circulation of the atmosphere and engage in fundamental research associated with synoptic meteorology of the region—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 2984 (September 30).

SENIOR LECTURER or LECTURER IN PSYCHOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, October 9).

PROFESSOR OF MICROBIOLOGY—*The Registrar, The University*, Reading (October 10).

SCIENTIFIC ASSISTANT (with a degree in botany or related subject) for the collation, abstracting and reviewing of biological literature—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (October 21).

CHAIR OF PURE MATHEMATICS—The Secretary, Queen's University, Belfast (November 15).

ASSISTANT CIVIL ENGINEER in the Office of the Engineer-in-Chief, at the War Office—The War Office, (C.5(A)), Room 503, Hotel Victoria, Northumberland Avenue, London, W.C.2.

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

DEPARTMENTAL ASSISTANT IN POULTRY HUSBANDRY at the School of Agriculture, Sutton Bonington—The Registrar, The University Nottingham.

LECTURER (Grade IIa) IN CHEMISTRY—The Clerk and Treasurer Dundee Technical College, 40 Bell Street, Dundee.

LECTURER IN MECHANICAL ENGINEERING (particularly Thermodynamics)—The Secretary, Royal Technical College, Glasgow.

LECTURER IN RUBBER TECHNOLOGY—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7

RESEARCH OFFICER (Senior Scientific Officer) at the Ebini Livestock Experimental Station, British Guiana, for the planning an supervision of research and other projects for the purpose of ascertaining the most economic methods of developing the minerally deficient savannahs of the area—The Under-Secretary of State Colonial Office, Research Department, Sanctuary Buildings, Grea Smith Street, London, S.W.1.

STEROID CHEMIST to conduct research on steroid metabolism i rheumatic diseases, with particular reference to excretion—The Chie Administrative Officer, Royal Hospital, Sheffield 1.

TECHNICIAN (Grade III) IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, University College, Gower Street, London, W.C.1 quoting 'Geography/3'.

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ACADEMIC FREEDOM AND THE STATE

IN the present international situation the question of intellectual freedom has more than academic interest in Great Britain and elsewhere, and one consequence of recent incidents is bound to be the voicing of fresh concern as to whether the provisions of the Official Secrets Act are adequate by themselves, and whether the measures put into force in accordance with the Prime Minister's announcement of March 15, 1948, have been pursued with sufficient vigour. As a contribution to more objective thinking on the whole issue, the publication in a recent issue of the *Proceedings of the American Philosophical Society* of the paper on "Changing Issues in Academic Freedom in the United States To-day"*, which Mr. H. O. Gideonse read at the autumn general meeting of the Society, will be welcomed by all who hold their freedom sacred. Under present conditions, proceedings in this field in the United States are of real interest in Great Britain, when all allowance is made for differing political conditions, and it is important that there should be a clear understanding of what is the position in the United States. Such an understanding in itself will contribute to the formation of standards of judgment which will prevent hasty or ill-considered action likely to be detrimental either to the advance of science or to the welfare of the State.

Mr. Gideonse addresses himself to three aspects of the problem of academic freedom, all of which have their counterpart in Great Britain, but only the first of which—teachers who accept political discipline in matters of science and scientific opinion—is related to the purging of the Civil Service announced by the Prime Minister two years ago. The impact on scholarly activities of United States Federal security regulations, especially in the field of the physical sciences, presents an exact parallel to a problem that has been troubling the Atomic Scientists' Association and others also in Britain, and the changing sources of academic financial support represent a problem that in Britain has already attracted the attention of the University Grants Committee, the Nuffield Foundation and of other bodies which are endowing research or higher educational activities.

On the first question, Mr. Gideonse gives a clear statement of the position in the United States and of the underlying issues. Together with the statements forming the first five chapters in the "Primer of Intellectual Freedom", edited by Prof. H. M. Jones for the Harvard University Press†, they permit an independent opinion to be formed on the situation in the United States and on the action taken by the universities. The first and most encouraging impression that emerges is the essential soundness of the position taken up by the American universities, and their clear grasp of what is at stake and what needs to be defended.

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* *Proceedings of the American Philosophical Society*, 94, No. 2: Intellectual Freedom and other Papers read at the Autumn General Meeting of the Society, November 4–5, 1949. Pp. 89–184. (Philadelphia: American Philosophical Society, 1950.) 1 dollar.

† Primer of Intellectual Freedom. Edited by Howard Mumford Jones. Pp. xv+191. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1949.) 22*s*. net.

Mr. Gideonse recognizes that the function of a university is the discovery and the dissemination of the truth in all branches of learning, and that, as such, the freedom of the academic teacher is essential to the preservation of free society itself. As a social tradition, he adds, academic freedom is morally anchored in this dedication to truth. This is little more than a paraphrase of Prof. Z. Chafee's assertion thirty years ago in a famous essay, since expanded into his book "Free Speech in the United States", quoted in the "Primer of Intellectual Freedom", that the true meaning of freedom of speech seems to be that one of the most important purposes of society and government is the discovery and spread of truth on subjects of general concern.

This is to argue that the safeguarding of academic or intellectual freedom is a social need and responsibility, and not merely the need and duty of the individual. To accept this point of view, however, only emphasizes all that Dr. J. B. Conant and Sir Walter Moberly, for example, have said as to the importance of respecting and maintaining the unique criteria for joining a community of scholars. Such a community cannot ask for its freedom to be safeguarded as a condition for the maintenance of its standards while it admits or harbours those who repudiate its standards and give their primary loyalties elsewhere.

"Granted honesty, sincerity and ability", wrote Dr. Conant, "there must be tolerance of a wide diversity of opinion." "Any teacher who is not against intellectual dishonesty", wrote Sir Walter Moberly, "is out of place in the university. The corollary of freedom is responsibility. For the university, some kind of effective self-criticism is the only alternative to forcible interference from outside." This issue of responsibility is hammered home by Mr. Gideonse in a way which leaves no moral prerequisites for freedom taken for granted, and makes no attempt to conceal the way in which certain action on students' activities by the Committee on Academic Freedom of the American Civil Liberties' Union completely disregarded the moral basis of our liberties.

This first part of Mr. Gideonse's paper puts the real issue of intellectual honesty and responsibility as the first condition of academic freedom in its rightful place; and he exposes the spuriousness of some of the claims for independent judgment which are made in a totalitarian society. The soundness of his appeal to the true and classic tradition is amply demonstrated by those papers of Karl Pearson on the scope and method of science, of Bagehot on the metaphysical basis of toleration, of Morley on intellectual responsibility, of Mill on liberty, Jefferson's first inaugural address, Milton's "Areopagitica", and the quotation from Bacon's "Advancement of Learning", all of which have been collected in the "Primer of Intellectual Freedom". Bagehot may well have the most pertinent word with his reminder that no government is bound to permit a controversy which will annihilate itself, and that toleration presupposes a state of society in which discussion is possible.

With Mr. Gideonse's endorsement of the by-law of the New School for Social Research, which states that "no member of the faculty may be a member of any political party or group which presumes to dictate in matters of science or scientific opinion", as a courageous and realistic translation in twentieth-century terms of the essential content of the classical ideal of academic freedom, we may pass to his consideration of academic freedom and federal security regulations. Here also he pleads for an understanding of the cultural conditions in which science can flourish, and of the dangers, against which Morley warned an earlier generation, of tampering with veracity, from any motive, or turning the edge of reason. A wide public conception of the extent to which continuous achievement in science depends upon a constant and open process of interplay of ideas, experiments and discussions is the first step to the formulation of security measures and procedures, whether in Great Britain, the United States or elsewhere. We must, indeed, have regard to the plain fact that, in certain fields which bear vitally on problems of national defence, the interplay of ideas and exchange of knowledge across national frontiers, which as Mr. Gideonse correctly notes have proved so fruitful in the past, have been interdicted by one important nation and her satellites. The free nations cannot ignore that danger; but no one has yet indicated what can be done to repair the loss.

Plainly as we must recognize that to attempt to continue a traffic in the one direction only would endanger security without benefiting science, it has still to be remembered that, if a nation is to secure in the service of its Government the ablest men o science, the conditions of service must be such as t attract first-rate men and nurture their creative powers. Dr. Conant and others have been right t urge that national security ultimately depends on ou ability to preserve the conditions which have attracte such men in the past and will enable Great Britai and the United States to maintain their leadershi and eminence in science. Mr. Gideonse puts thi issue clearly; but there is nevertheless a clash, an he gives no indication as to where or how the balanc is to be struck between the short-term and th long-term needs of national security—between effe tive safeguards against the disclosure of militar secrets, and the maintenance of the open interchang of thought and results upon which the advance science depends.

On the third issue, that of the changes of sourc of financial support for academic activities, M Gideonse notes, as others have done, that the shrin ing bases of private financial support, whether in fe or in endowment, and the increasing share of gover ment agencies in financial responsibility, ha brought new dangers to free scholarship. There is increased risk that some of the best of our creati talent may devote their most fruitful years to wo selected by government agencies rather than scholars themselves, and there are correspondi hazards to qualitative standards elsewhere. Moreov the vigorous promotion by government grants research in the physical and biological sciences, a concurrently of the training of staff for expansion in these fields, may widen the gap that already threatens the stability of society, between scientific and technical change on one hand, and the relative inflexibility of the moral, social and legal framework of society, on the other.

More extensive study of techniques of social adjustment, including an imaginative and constructive programme in the humanities, might well help to increase the stability of society; but, as Mr. Gideonse points out, legislators find it very hard to distinguish between the study of social change and the advocacy of social change. If the State is to be increasingly responsible for the financial support of physical and biological research, academic groups will carry a special responsibility for seeing that social and humanistic studies do not shrink to proportions that will themselves constitute a major hazard to the future of free society, and thereby to the freedom even of the physical scientist.

Freedom, in the view of Mr. Gideonse, is first of all availability of choice, and the survival of freedom calls for an intellectual understanding of the choice, as well as the development of a will to choose. A free community emerges whenever internal checks can be substituted for external constraint; and, conversely, freedom is endangered if in a free community shared values are no longer sufficiently vigorous to create the moral cohesion on which the discipline of free men rests. Mr. Gideonse's paper is not merely an interpretation of American thought on this issue; it is also a challenge to further constructive thought on the problem everywhere; and with the challenge, his paper provides material for such thinking which is no less stimulating than those classic essays which Prof. Jones has collected alongside of modern material in his "Primer of Intellectual Freedom". No one who reads and thinks over these papers can remain in much doubt that, on one hand, this is an issue which vitally affects the welfare of society as well as the advance of science, or that, on the other hand, it is not simply an issue of freedom but equally one of intellectual honesty and of loyalty to the strict discipline of professional ideals and traditions.

SIR ARTHUR KEITH, F.R.S.

An Autobiography

By Sir Arthur Keith. Pp. vii+721+6 plates. London: C. A. Watts and Co., 1950.) 25*s*.

THE export of young people from Scotland and Wales, and, in the case of Scotland, very notably rom the Aberdeen region, is one of the means hereby the higher initiatives are maintained in British life. Frugal homes, hard work, courage to ace difficulties and a strong spice of ambition are mportant factors; and most of these are expresions of what Bergson so aptly called *élan vital*. The names that come into the early pages of this ook amply confirm established beliefs about Aberdeen's value to our common life. One need but y, by way of illustration, that Sir Arthur Keith nd Sir Leslie Mackenzie were class-fellows in the aculty of medicine, at the University of Aberdeen. Sir Arthur's friends well remember their anxiety for him more than twenty years ago, when it was feared that pulmonary tuberculosis and other troubles were bringing him down, and Lady Keith was trying to nurse him. Yet, he has now survived her by fifteen years, and this book, written when he was already over eighty, is full of zest.

To the Aberdonian qualities above-named should be added that of mutual aid and the loyalty which accompanies it. Keith's grateful acknowledgments to James Trail, professor of botany at Aberdeen, are a pleasing illustration here.

Keith was early impressed with the importance of Darwin's contribution to thought about man. Evolution in the Darwinian sense, but, as time went on, with the additions made by the geneticists, was to be the keynote of a refreshed view of social problems so often befogged by wishful thinking. To Keith there seems to be no evidence for the existence of mind, or so-called spirit, apart from its physical basis, and he has long worked for the Rationalist group, of which his friend Mr. Charles Watts, the publisher, was the centre as long as he lived. This brought Keith into many controversies; but we must note that he kept a very affectionate regard for Sir William and Lady Bragg, who took a very different view, and he liked and enjoyed discussion with H. G. Wells, who also differed deeply in quite another way. Keith thought of nationalism as part of the evolutionary process; Wells saw it as an obstacle to the universalism for which he strove. Keith's exposition of nationalism in evolution has often been taken, largely mistaken, for a glorification of war. Perhaps the author's perennial difficulty in finding just the expression he wants is partly accountable here. The story is told of the rise from primal poverty and struggle to a position, not of affluence but of influence, as one of the men who stood for science in the public eye and, at the same time, tried to contribute, himself, to the advancement of natural knowledge, especially in anatomy. He has been an interpreter, perhaps, in the main; and it is often difficult to put one's finger on a particular part of an interpreter's work and say this is his great personal contribution. But one may say without reserve that Keith has been a major contributor to the study of human evolution. His early belief in the high antiquity of our race became dim as the Galley Hill skeleton came to be assigned to later post-Pleistocene periods; but one hopes he may yet tell us how he reacts to Dr. K. P. Oakley's interesting work tending to show that the Swanscombe bones, probably nearer *Homo sapiens* than Piltdown is, are so much more ancient than the latter.

Sir Arthur made the Museum of the Royal College of Surgeons a famous centre of scientific discussion; with his friend, Sir Buckston Browne, built up the Surgical Research Centre at Downe; and, in addition to all this, he spoke for science to the general public in Britain and America.

The autobiography is a long series of glimpses, some of which we should have liked to have in more expanded form. He makes little attempt to hide or excuse what he considers his mistakes or faults, not even in famous discussions with Elliot Smith, to whose ability he pays generous tribute. His more intimate personal relations are discussed with considerable frankness, and we have a picture of an indefatigable worker full of his deep belief in Darwinian principles, and ambitious to play the part of their interpreter to his generation of students of man. There is something peculiarly appropriate in the fact that Sir Arthur has spent his years of retirement within sight of Darwin's old home, which he helped to dedicate as a public trust in memory of the great naturalist.

MONOGRAPH ON THE LARYNX

The Comparative Anatomy and Physiology of the Larynx

By V. E. Negus. Pp. xix+230. (London: William Heinemann Medical Books, Ltd., 1949.) 30*s*. net.

MR. V. E. NEGUS has enriched a masterly condensation and re-arrangement of his book, "The Mechanism of the Larynx", by further observation and original thought during the past twenty years in order to produce the present work. The evolution of the larynx is traced from its earliest appearance, and a critical assessment of its anatomical modifications is correlated with the habits and physiological requirements of the animal.

Laryngeal modifications associated with the prevention of entry of fluid or foodstuffs into the lungs are discussed relative to the position of the larynx and the presence of lateral food channels. The calibre of the air passages, the variations in the form of the laryngeal cartilages and the influence of an inlet valve at the glottis are judged according to the habits of the animals, including the free use of the forelimbs. Emphasis is directed to the importance of air sacs, whether buccal, laryngeal, thoracic or abdominal in position, as they function in the re-breathing of air by an internal mechanism of respiration. Sound production as a means of communication necessitated by the normal habits of animals is studied by an extensive survey of comparative anatomical material, and the relationship of sound production to the sense of hearing is fully discussed. The author accounts for all the characteristics of the human larynx by reasons other than phonation, showing, however, that the larynx of man proves to be a tool equal to the demands of his intelligence.

A chapter on the "Anatomy of the Human Larynx" describes its regional anatomy in detail, and includes sections on its prenatal and postnatal growth and position. "Observations on the Evolution of Man from the Evidence of the Larynx" provides a stimulating topic for Appendix 1, which relates human evolution to laryngeal morphology and details the degenerations and altered position of the larynx associated with the adoption of an erect posture. The progressive reduction in the powers of olfaction and exercise tolerance is seen to be compensated by increased cerebral development.

Appendix 2 discusses the general adaptability and evolution of those structures which are utilized in sound production. The resonators, the separation of the epiglottis from the soft palate and the general structure of the oral cavity are all subjects for comment. Evidence presented suggests that early man was provided with a larynx as efficient as modern man but lacked the intelligence to use it. The author is convinced of the truth of Semon's Law and in Appendix 3 discusses critically the relevant factors in the evolution of the sphincteric and dilator muscles of the larynx.

The method of arrangement and production of this book is excellent. The illustrations are profuse in number, beautifully reproduced and include outlines of animals studied, as well as regional dissections carried out by the author. Many of the specimens from which illustrations are drawn are housed in the Royal College of Surgeons' Museum, the number given to the illustration in the book corresponding for ease of reference to the number in the collection.

A foreword is written by Sir Arthur Keith, and a list of chapters and headings is reinforced by a list of illustrations arranged under chapter headings, as well as a general index and an index of illustrations arranged alphabetically. The author explains the absence of a bibliography as an attempt to curtail the size of the book; the eleven chapters and three appendixes each possesses a summary of conclusions helpful to the reader. Those interested in the larynx, either as a subject for research and teaching or from a clinical point of view, will benefit by the wealth of information contained in this book.

C. HOWARD TONGE

SOME STUDIES OF BACTERIAL MORPHOLOGY

The Cytology and Life-History of Bacteria

By Dr. K. A. Bisset. Pp. xii+136. (Edinburgh: E. and S. Livingstone, Ltd., 1950.) 18*s*. 6*d*. net.

AN increasing interest, particularly over the past few years, has been directed to the fundamentals of bacterial structure and behaviour. In this short monograph, much of the work already published is reviewed, and Dr. K. A. Bisset describes the results of his own studies and discusses thei interpretation.

While orthodox methods of staining dried preparations are of considerable value in applied bacteriology they are firmly criticized here because they obscure delicate internal structure and may often produce artefacts. A number of special techniques for the demonstration of chromatinic material or of cell wall and other surface components is given; of these the author finds most informative the acid-Giemsa method of Robinow and makes extensive use o tannic acid-violet staining and of colony imprint preparations. It is disappointing that the possibilities of the phase-contrast microscope could not be explored here; brief reference is made to the valu of this method and to the more limited application of electron and ultra-violet microscopy.

Chromatinic and other structures have bee examined in many forms of bacteria at differen phases of growth and multiplication, and it possible to define two main types of fission—that unicellular smooth organisms and that of rough form which possess four cells. The same refinements technique are used for demonstrating stages in the formation of spores, microcysts or resting cells. T more controversial aspects of the subject are discussed in a section on the nature of the bacteri chromosome and in later chapters which deal wi sexuality, life-cycles and macroformations.

The interpretation of observations of this sort fixed and stained preparations is often far from eas and it seems likely that the use and further develo ment of techniques for examining living bacteria a likely to prove of great value in resolving some these problems. It is significant, for example, th Klieneberger-Nobel has only recently accepted th the L forms of certain bacteria represent a gonidial phase and are not symbionts, as prolonged and careful study had indicated.

Any suggestion for simplifying the classification of bacteria is likely to prove attractive ; how far this is possible along the proposed lines of structure and life-history would seem to depend on the regularity of these strictly morphological criteria, and limits of variation might well require more exact definition than is at present possible. In conclusion, Dr. Bisset makes a plea for correlating genetical with cytological studies, and claims that such genetic evidence as there is supports his own findings and their interpretation. The main thesis, that bacteria possess essentially the same complexity of structure and function as other cells, is carefully elaborated in the text and is beautifully illustrated by many line drawings and striking photographs.

C. F. Barwell

FERTILITY AND STERILITY IN MAN

Human Fertility and Problems of the Male

By Dr. Edmond J. Farris. Pp. xvi+211+10 plates. (White Plains, N.Y.: The Author's Press, Inc., 1950.) n.p.

THE author, who is an executive director of the Wistar Institute of Anatomy and Biology in Philadelphia, designed this book for the use of physicians and scientifically minded laymen alike. The material, however, has been derived almost exclusively from the author's own researches, and consequently the reader should not expect to find in the book either general information or an appreciation of the whole problem of human sterility in all its manifold aspects. He will be confronted instead with an account of studies carried out by the author and his associates during the past decade, chiefly on the causes and alleviation of sterility in the human male.

In agreement with other workers in this field, the author comes to the serious conclusion that a large percentage of husbands in America suffer from various degrees of subfertility which in many, though by no means in all cases, is associated with abnormal composition of semen as assessed by microscopic examination of spermatozoa. The principles underlying the microscopic analysis of semen constitute the major theme of the book, and the author emphasizes particularly the point that an estimate of the otal number of *motile* spermatozoa in an ejaculate offers a much better criterion of semen quality than a simple determination of sperm density, that is, the number of sperm, regardless of their motility, per ml. semen. It is reassuring to know that this principle is being applied by the author to the numerous cases which come under his observation. In Great Britain the principle of 'percentage motility' and 'degree of motility' has long been recognized as indispensable in the veterinary practice of semen analysis, and, thanks to the studies of Clare Harvey and Margaret Jackson, it is now applied in the examination of uman semen as a routine.

On the point of preserving human sperm at low temperature, the author's experience has been rather scouraging ; but then his methods vary considerably from those recommended by Parkes and others as absolutely essential for the survival of vitrified human spermatozoa. There is no mention in the book of either the biochemical or the physicochemical aspects of human semen. However, one has to bear in mind that the modern chemical and physical methods of semen analysis are relatively new and based upon the use of animal semen. It is very much to be hoped that the next decade will offer ample opportunity to the clinical investigator to apply to human semen some at least of the modern methods developed by research workers in the more advanced and wider field of fertility and sterility in animals.

T. Mann

HEALTH EDUCATION AND THE ADOLESCENT

Fundamentals of Health and Safety

By Grover W. Mueller and Dr. Elizabeth Chant Robertson. Pp. ix+345. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 14*s*. net.

THIS is an excellent book, the purpose of which is to give the adolescent a broad understanding of how his body is made and how it works, what forces are acting upon him, how to get on with other people, what the community is doing to promote health and prevent disease, and what he himself must do to promote his own health and to avoid endangering the health of others. The theme throughout is that the health of the adolescent is mainly his own responsibility. The reader is addressed personally and is encouraged to seek in his own body the illustrations of what is said.

The lessons to be learned about how to care for oneself and others emerge naturally in each section, and therefore become not a set of arbitrary rules but the logical outcome of what we know about the mind and body and their health. In relevant places the book includes instruction in elementary first-aid and gives simple corrective exercises for minor defects of posture. Its approach is positive, and it encourages the reader to make the most of his own physique and personality. At the end of each chapter the reader's participation is invited by the posing of straightforward questions and of questions for which alternative right and wrong answers are given, and by a list of things that the reader is asked to do. A number of tests—for example, a weekly diet score test—are set at different points in the book.

On the whole, this book serves its purpose admirably. It is simply and lucidly written, and, although there is inevitably some over-simplification, it is basically sound and full of common sense. It is obviously admirable as a text-book for American high-school children, and would be useful as a teaching brief for teachers of secondary-school children in Great Britain. The section dealing with accidents is particularly good, and in the chapter entitled "Ourselves and Others" there is valuable teaching on human relations by the use of stories about the experiences of other young people.

The only serious weakness is that the sections dealing with human reproduction and sex relations are too short and too superficial. Adolescents are entitled to expect, and should find, more detailed and helpful information on these subjects in a book that is specifically addressed to them. Nevertheless the book does admirably what it sets out to do, namely, to give the adolescent a broad grasp of the fundamentals of health and safety.

Robert Sutherland

The Systematic Identification of Organic Compounds

By Prof. Ralph L. Shriner and Prof. Reynold C. Fuson. Third edition. Pp. ix+370. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 32*s.* net.

IT is probably no exaggeration to say that every monthly issue of the American Chemical Society's *Journal* contains at least one footnote reference to 'Shriner and Fuson'; this is a striking tribute to what is primarily a students' text-book.

Considerable expansion has occurred since the first relatively slim volume appeared fifteen years ago, the present edition being practically twice the size of the original. Basically, the same system has been followed, namely of effecting a first classification, after the usual preliminary observations, by means of solubility (physical and chemical), which is then followed by the more orthodox group reactions. Much of the subject-matter has been re-grouped and re-written; additional classification reagents have been introduced and the preparation of further derivatives described. The tables have been increased in length but not in breadth, so that some of the derivatives for which procedures are given are not tabulated. This seems to be deliberate, since literature references to group reagents are given; but it does mean that derivatives recorded incidentally will probably not be encountered. A minor criticism, which applied equally to the first edition, is that densities, in the few places where they are given, are quoted for an assortment of temperatures ranging from 0° to 25° C.; this is occasionally unavoidable, but for most of the compounds in question, and particularly for hydrocarbons, reliable figures for 20° C. are available. Further, it is strange to see (p. 236) diphenylamine placed among the liquid amines as well as the solid. On the other side, it was formerly difficult to trace the position of a particular compound in the tables, even when the page was known from the index; this has now been overcome by a very simple device.

Gmelins Handbuch der anorganischen Chemie

Achte völlig neu bearbeitete Auflage. System-Nummer 18: Antimon. Teil B2: Schluss des Elements verbindungen bis Antimon und Jod. Pp. 129–496. 83.60 D. marks. Teil B3: Schluss der Verbindungen. Pp. xxi+xvi+497–564. 24.75 D. marks. (Clausthal-Zellerfeld: Gmelin-Verlag G.m.b.H., 1949.)

PART B2 of this section on antimony deals with a few iodine compounds and compounds of antimony with sulphur, selenium, tellurium, boron, carbon, silicon, phosphorus and arsenic. As usual, the physical and chemical properties are very fully covered. Phase rule diagrams are given.

The second of these two publications, Part B3, begins in the middle of the electrical properties of antimony, including a section on the antimony electrode, then deals with the chemical and analytical properties of antimony, and the antimony compounds with hydrogen, oxygen, nitrogen and halogens as far as part of the iodine compounds. It thus covers much of the interesting and important parts of the chemistry of antimony. The section on the antimony electrode, which is fully illustrated (an unusual feature in "Gmelin"), is particularly noteworthy. The section on antimonic acid includes the modern formulation as a hexahydroxy compound; but the individual antimonates are not included, these being treated in other volumes under the metals concerned. Compounds quite unknown in the separate form and assumed only from spectra, such as SbF, receive as detailed treatment as the known compounds. This volume is an excellent example of the high standard of the whole work. J. R. P.

Geometry

By Prof. H. G. Forder. (Hutchinson's University Library, No. 19.) Pp. 200. (London: Hutchinson's University Library, 1950.) 7*s.* 6*d.*

THIS is a book of an unusual kind. It is not a text-book, giving a detailed treatment of a limited part of the subject, but an attempt to give a general outline of almost every kind of geometry, from the most ancient and elementary to the most modern and abstruse. It is intended for non-specialists; most of the book assumes only a knowledge of elementary geometry and algebra, though the later chapters require some differential calculus. The first chapter deals with Euclidean geometry by means of displacements and transformations. The second and third chapters deal with plane curves and co-ordinate geometry. The fourth deals with projective geometry. In the fifth and sixth we come to non-Euclidean geometry, with a discussion of the logical structure of different geometries. The seventh and eighth deal with solid geometry, algebraic and differential. The ninth has some of the properties of higher plane curves. The tenth and eleventh give an account of geometry of *n* dimensions, including Riemann's work, which has attained such prominence in the theory of relativity. Results are given; but it is, of course, impossible to give, in a small book, even a sketch of the proofs of the theorems in the last chapter.

A Bird Photographer in India

By E. H. N. Lowther. Pp. xii+150+79 plates. (London: Oxford University Press, 1949.) 21*s.* net.

HERE Mr. E. H. N. Lowther gives us the results of many years work with camera and hide among the birds of India. Bird photography in the best of climates and under the best of conditions has its trials and difficulties. The heat prevailing in the plains during the main breeding season provides an adverse factor likely to daunt all but the most enthusiastic of bird photographers; but it never daunted Mr. Lowther, who has worked year after year on a diversity of species and with remarkably successful results.

The seventy-nine plates in this book testify no only to Mr. Lowther's zeal and skill but also to th very wide field he has covered. To refer to even few of the birds he has 'shot' would make a length list. It must suffice to say they are numerous an various—we begin with a crested swift on its nes and conclude with a king vulture; jungle nightjar skimmers and hornbills being among those e countered as we turn over these fascinating page But it must not be thought from this that M Lowther's volume is only a picture book, for such far from being the case. His observations are man of high interest and afford excellent reading. short, despite his photographs having received fir mention, they take their proper place as fine illu trations to the record of a naturalist's observatio on the bird-life of India, a record on which v congratulate him. FRANCES PITT

SCIENCE, RELIGION AND MORAL JUDGMENTS*

By the Right Rev. E. W. BARNES, F.R.S.
Bishop of Birmingham

WITH the discovery—roughly in the fifteenth century—of the literature of Græco-Roman civilization, the medieval order of Western Europe began to break up. Ancient beliefs crumbled: many old religious superstitions, in spite of the efforts of the powerful and well-organised medieval church, began to seem foolish. Moral judgments changed: for example, to burn a man for heresy began to seem barbarous; to drown an old woman as a witch lost such moral seemliness as it had ever had. Changes in belief led to religious divisions, and they in turn to wars. The more conservative wings of the ancient church continued to proclaim the truth of so-called immutable beliefs; but they silently abandoned ideas and practices which had lost their cogency. So it came about that the post-renaissance world differed profoundly from that of the Middle Ages. The old unity of Western European civilization collapsed. The new disorder, though regrettable in many ways, showed the healthy vitality of hopeful progress associated with more reasonable beliefs.

We are passing from the post-renaissance world to a new era. The discoveries of science are leading to world-wide changes, religious and moral, as profound as those caused in Western Europe by the spread five centuries ago of the ideas of classical civilization.

The first effect of the changes is to produce quarrels out of which wars may only too easily arise. The old outlook coalesces naturally with religious conservatism. The new outlook is the basis of political and social revolutions.

It must be remembered, moreover, that Christian churches, in spite of the teaching of Christ, almost invariably approve of war, 'in a just cause' as the saying is. But humanist intellectuals, with the new scientific outlook, tend to repudiate war and to press for international peace. Quite unexpectedly, a new moral judgment that war is barbarous has arisen among the men of science whose discoveries, to their profound regret, have been used to make war more devilish than ever.

This moral condemnation of war, which in the past has been almost entirely limited to the Quakers, is a surprising outcome of the scientific era. As a characteristic of scientific humanism it is worth areful study. The new humanism is often condemned s the product of intellectuals who have no religious convictions; and it is asserted that such a lack of eligious enthusiasm is associated with social ensitiveness. But, in fact, the fundamental principles f the new era are two in number, the veneration of nowledge and research and a regard for man's social ell-being. Analyse these principles and one begins stinctively to say to oneself, "Thou shalt love the ord thy God with all thy mind" and "Thou shalt love hy neighbour as thyself". Who is my neighbour? The reply comes back through the centuries: he is the hated enemy of my people—the Samaritan.

The scientific intellectual, trying by his research to understand more fully the pattern and significance of the universe, and rating kindness as a more valuable social principle than the patriotism that springs often enough from fear, is a religious man, Christian in sympathy, even though he stands apart from formal religion.

Yet, often enough, the new outlook of the scientific era is assumed to be anti-Christian or even atheistic. Current controversy uses the assumption, and it gains plausibility from some Communist teaching; but it is not justified by facts.

The modern intellectual finds God through Nature: Spinoza's *Deus sive Natura* is at the basis of his theology. He builds upon research and discovery rather than upon revelation. He does not on principle repudiate revelation. He retains an open mind because he finds that too often what is asserted to be revelation is associated with those traditional judgments of fact and fiction, of right and wrong, which he rejects. But his religious sympathies find a basis in the fact that his discoveries in the realm of physics reveal a planned world, the product apparently of a Mind, like to, though in quality and power transcendently surpassing, that of man. Current biological progress confirms and amplifies this understanding. So it becomes difficult to deny the existence of God, if the term be applied to the active Mind behind phenomena. The purpose of the plan of creation is by no means clear, or at any rate as clear as we could wish. Yet, arguing from instincts which are, he is convinced, of supreme value, the intellectual who builds religious faith on science tends to believe that God's nature and purpose are to be found in kindness. So in human life his final emphasis is on the brotherhood of man; and he tends increasingly to stress the need for kindness to lower animals who are also man's kinsfolk.

Probably it is true to say that the teaching of Jesus is more valued in the modern scientific civilization that is now being built up than it was in the post-renaissance world. Consider, for instance, the Chinese civilization that is now under the impact of changes emerging from Western humanism. It was polygamous, its leaders fighting for wealth and power. The new revolutionary leaders of China have surprised the world by their practical repudiation of traditional avarice. Largely by moral influence they have conquered territories containing millions of men with comparatively little fighting; they have now denounced polygamy and cognate ills. Thus a new civilization, Confucian but also scientific, in sympathy with Christian idealisms, is arising among a people who can boast the oldest tradition of continuous civilized living known on earth. We cannot say what will happen when Chinese universities are fundamentally transformed by modern science—so far the transformation is in its infancy—but the future is of much promise. We can gain hope from this promise, for Western European civilization, under surface hypocrisies, had anti-Christian standards of living similar to those of unregenerate China. There is in science an austerity not to be found in war or predatory business. For this reason a scientific education is a purifying influence: it is a true humanism.

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* Substance of the Evening Discourse delivered on September 3 at e meeting of the British Association in Birmingham.

We must lay great stress on these facts as we consider the changes in moral judgment to which I wish now to direct attention.

The most significant development which we observe in our science-controlled world is the vast increase in human fecundity. Medicine, as never before, is winning the fight against disease, and especially against illnesses fatal to infants and adolescents. As a result, population in most areas is increasing faster than food supplies. Malthus saw this possibility a century and a half ago. Happily the increase since then of the fertility of newly developed areas and the slow progress of preventive medicine saved the situation for the time being. Now the world begins to find itself almost everywhere over-populated.

Analyses of the causes of unrest in various parts of the world have of late been fairly frequent. Almost always one finds embedded in them, behind a façade of political words, some reference to a population increase associated with semi-starvation. For instance, social disorder in some of the West Indian islands is dangerous. Poverty is endemic. One island has been described as a vast slum where legitimacy statistics are lamentable. Can we be surprised that in some of these islands the inhabitants avail themselves of a citizenship which enables them to overflow into Britain, where we find their presence a social burden? I put to you the thought that the old command, "Be fruitful and multiply and replenish the earth", could be deemed divine so long as the world needed more human beings. The primitive need has passed. Now the world needs more good human stocks; but inferior stocks are increasing far too rapidly and are a menace to the future.

It is unnecessary to say that no race, no human group, no family, thinks itself rightly to be classed as inferior. The more numbers increase, the fiercer becomes the struggle for existence. Yet, almost everywhere, the self-denial needed to limit population-increase is deemed a folly: the consequent rapidity with which the world-situation alters for the worse cannot but cause anxiety to all thoughtful people. Half a century ago most churches condemned birth-control as immoral. To-day only the most reactionary maintain that view in Great Britain. There seem to be signs that the Roman Catholic Church is modifying its attitude even in southern Italy, where dreadful poverty and fierce discontent are increased by American refusal to accept mass immigration. I personally can find nothing in Christ's teaching to cause us to welcome unrestricted population-increase when its direct outcome is a vast growth of human misery.

Once it is seen that in the new science-controlled world we are in danger of over-population, the doctrine that human life is inherently sacred becomes questioned. The doctrine remains axiomatic if the life be that of one who could be said to have been made in the image of God, a good man, healthy, and strong, to give to humanity moral aims and a wholesome example. Yet, while the need for great and good leaders of humanity was never greater than at present, we cannot assert that love of our neighbour is a principle that should prevent us from trying to limit the increase of bad stocks. We should give to all human beings who are born opportunities of healthy and wholesome living. But we must accept the certainty reached by eugenic investigation that inherent degeneracy is not a product of slum life. Nor can it be cured by better housing conditions or more ample food supplies: it is a consequence of dysgenic changes; and of their ultimate origin we are ignorant. So the question arises: Is human life always sacred, whatever its quality or circumstances?

In the realm of this inquiry, as we all know, disturbing problems insistently press forward. Would God, as Christ revealed Him, in all circumstances disapprove of euthanasia? Owing to the progress of medical science, the length of life of men is increasing. We are living longer than our parents, and many live too long for happiness. It is becoming almost a commonplace to hear a man say that his father lived too long: he would have been happier had death come sooner. Sometimes the man will add, "he and the rest of the family would have welcomed euthanasia". So clergymen and others of undoubted sincerity and Christian earnestness are pressing for legal change.

Other associated alterations of public opinion are showing themselves. In the post-renaissance era which is now reaching its end, suicide carried a grave social and religious stigma. But now a kindly coroner makes a formal excuse and a religious service is rarely refused when suicide has ended physical malady. Of course, euthanasia, as a mode of death, differs *in toto* from suicide in that a man is not renouncing his own life but concurring with the judgment of others. But can we always say that either is an affront to God as Christ revealed Him? Most of us, while condemning suicide in the abstract, would suspend judgment in a particular case, urging lack of knowledge of the circumstances. Enforced suicide excites indignant condemnation of the man who imposes it, though not of the victim; condemnation of Hitler, not of Rommel.

Probably the test of cruelty will be increasingly applied to a number of the problems now becoming insistent. Hitler's treatment of Rommel was cruel, and his agents, like himself, deserved to be punished for cruelty. But when a medical man gives an overdose of morphia to a patient likely to have but a short time of misery while life lasts, he is animated by kindness, not by cruelty. He combines, in fact, knowledge and goodness, the two fundamental principles on which, I have suggested, our new scientific civilization will rest.

In the immediate future our new civilization is likely to have many a struggle within itself as its leaders see the ideal that should be sought and lack the knowledge by which it may be attained without action which some will judge to be worthy of moral censure.

We have come to know that both grave physical defects in man and mental degeneracy are alike inherited. Progress in the science of genetics during the last half-century has revealed that the genes in the chromosomes of the living cell, alike in human beings and in other animals and plants, are carriers of hereditary units. These units change, sometimes for the worse, sometimes for the better. The causes of the changes are little understood, though it is known that some of them can be induced by radioactivity. When deleterious units appear, a new type of human being results with physical or mental defects that may make it unfit for civilized life. So far we know little of the location of defective genes within the living cell and nothing as to how they can be eliminated before mating. But there is a close likeness between human beings and other higher mammals; and no breeder of domestic animals would breed from individuals similarly tainted. Sooner or later, as over-population becomes acute, the question of preventing the increase of tainted human stocks will have to be faced; and violent controversy is likely to ensue. Our present knowledge is sufficient to warrant the statement that sterilization in cases of mental defect would only be partially effective, though in view of the increasing number of mentally defective persons in Britain there is much to be said for the argument that half a loaf is better than no bread. Too often in our newspapers we read the verdict "guilty but insane" after some dreadful crime by a mental and moral degenerate. Is the outcome of the verdict to be lifelong imprisonment rather than kindly euthanasia? I confess that I can give no confident answer to this question.

From time to time, new mutations lead to the birth of children horribly defective or deformed. They can never grow up to have a normal happy existence. The question of euthanasia at birth for such infants is seldom discussed in public, but undoubtedly the practice is accepted as a regrettable necessity by some members of the medical profession. It would not appear to conflict with the fundamental religious principles of our developing scientific civilization.

Objections to sterilization and euthanasia gain strength from a belief that the defects to which they could be applied arise from what we may popularly describe as 'slum conditions'. The belief, as I have said, is mistaken. But it is strongly held and, like other primitive though mistaken beliefs, is most difficult to eradicate.

Mental and moral defectives tend, in populous industrial areas, to congregate in districts where their habits of life lead to overcrowded and insanitary houses. An enthusiast for better housing and social reform, once he has convinced himself that a bad environment produces human degeneracy, tends to find his belief confirmed by all he sees; and regards eugenic reformers as hard-hearted *bourgeois* indifferent to the unhappiness and suffering of the proletariat. Such a man may well become a dangerous reactionary, though he fancies himself a progressive socialist or even communist.

The emergence of sub-normal groups in an over-populated land is at present a cloud no bigger than man's hand. Before another century has passed is likely to become a cloud covering the whole sky.

Evidently the need for genetic research applied to umanity is vastly important. Unfortunately, there already evidence that differences of opinion as to genetics are likely to lead to political and racial uarrels as violent as were religious differences four centuries ago.

The use of euthanasia or sterilization to prevent he increase of tainted stocks is sometimes thought be a form of punishment, and opposition to either linked to objection to capital punishment. The undamental difference needs to be continually mphasized. The mental or physical degenerate is t defective because of any personal fault, and the question of punishment does not enter in. Society needs, and will increasingly need, to prevent the increase of degenerate human stocks. Any action taken must both be kind to the individual and also tend to the ultimate welfare of mankind. It differs *in toto* from the stern punishment which brings a murderer's life to an end. Dislike of capital punishment is undoubtedly increasing, and one reason is the belief that hanging is unnecessarily cruel. Life imprisonment is also cruel, though not so brutal. Should a murderer be likely to repeat his crime, if released, public opinion in the future will probably demand, not his execution, but his painless extinction.

Another problem raised by the destruction of human life is that of abortion. The destruction of an unborn child in a case of rape or to preserve the mother's life receives wide approval. But the use of abortion to protect a girl's good name after a moral lapse would lead to many abuses if ever the practice were legalized. Many an illegitimate child is potentially a valuable citizen, and the killing of such a one should not receive and, in fact, is most unlikely to obtain the approval either of a Christian or of a religious scientist. The problem of abortion is associated with our ethical standards as shown in marriage and divorce. In this realm few moral teachers would reject the ideals of Christian monogamy. These ideals seem to be winning their way in China; but there is unfortunately no evidence of similar progress in the Western democracies. It is in fact, most disconcerting that regard for them seems to fall as the independent status of women rises. So far as such ideals are concerned, biological science seems to be completely neutral, especially now that venereal diseases can be said to be conquered. Among the tasks of the future the maintenance of a high standard of sexual ethics will probably be one of the most difficult. In no other realm of human activity will the union of scientific enthusiasm with Christian idealism be more valuable. I have said that the two main standards of the new scientific civilization will be knowledge and kindness. True to these standards, men and women in marriage must seek to understand the mind of the Creator—or, in Christian language, the Will of God—and to strengthen their union by love.

Sometimes, when the problems of over-population to which I have directed attention are discussed, the plea is made that war will recurrently end our troubles and therefore deserves our approval. There is, unfortunately, little doubt that atomic warfare can be so developed that mass-extermination results. It seems that such a development of atomic energy will be associated with the growth of great industrial areas and that such crowded areas in turn will be peculiarly liable to atomic destruction. Yet it is impossible to view without horror either the manufacture or the use of atomic weapons. The use of such weapons might empty an overcrowded world, but it would bring grave suffering of which most certainly God, as revealed by Christ, would not approve; and which no human being can rightly excuse. He who has heard the call "Thou shalt love thy neighbour as thyself" may without hypocrisy approve of bringing human life to an end when its burden has become intolerable: he cannot, to protect himself from fancied or real enemies, approve methods of mass-murder and mass-mutilation. If the alternative be a pacifism willing to endure and to suffer, let us choose it. We may lose our lives but the loss will ultimately be in the service of mankind.

RHEOLOGICAL PROBLEMS IN BIOLOGY

INTERNATIONAL COLLOQUIUM

DURING July 26–28, a colloquium was held in Lund, attended by workers in a variety of fields of biological study, with the object of surveying problems relating to "the flow and deformation of matter". Such problems are essentially part of the subject-matter of physics; but physicists in the nineteenth and early twentieth centuries quite properly concentrated on the simplest types of rheological behaviour—the Newtonian fluid, with no relevant properties beyond a viscosity and a density, and the Hookean solid, of which examples are to be found in every text-book but in very few other places.

Biological science provides almost no examples of such simple types of behaviour, and scarcely any biological problems have proved to be amenable to treatment along lines suggested by nineteenth-century physical theory. Poiseuille, who wanted to study the flow of blood, had to give it up and study instead the behaviour of flowing water. He made thereby contributions of great value to physics, but left his original physiological problems as obscure as ever.

Developments in the present century—notably the introduction of plastics—directed attention forcibly to the flow and distortion characteristics of materials of high molecular or particle weight, leading to extensions of physical theory which seem likely in the near future to have application to biological problems. A survey of such problems as they exist to-day seemed desirable, and the meeting at Lund was accordingly arranged by the Joint Committee on Rheology of the International Unions of Physics and Biology.

The colloquium, attended by forty to fifty workers from several different biological sciences (and incidentally of ten nationalities), was opened at an informal reception by a short speech of welcome from Prof. Georg Kahlson, who had generously put his Physiological Institute at the disposal of the organisers both for the communication of papers and for the equally important informal discussion that went on during the subsequent three days in the gardens of the Institute.

At the first formal session, under the chairmanship of Prof. Hans Burström, dean of the Faculty of Natural Science at Lund, the meeting considered, appropriately, the rheological properties of protoplasm. Opening the session, Prof. W. Seifriz (Philadelphia), showed films of protoplasmic streaming in the slime mould, an astonishing demonstration of a circulatory mechanism with no permanent vessels and no discernible motive power, with the odd characteristic that the direction of flow is reversed every minute or so. This streaming can be reversibly inhibited by narcotic agents and stimulated to greater intensity by agents such as produce excitation in laboratory animals. The rheological properties of the cell nucleus were the subject of a communication from Prof. J. E. Harris (Bristol), who has measured the rate of fall of the nucleolus under gravity through the nucleus in the oocytes of several species of echinoderms, and revealed unmistakable evidence of thixotropy in the nuclear material. The session was concluded by an account from Prof. H. Pfeiffer (Bremen), of his work on the dichroism of flow in protoplasm streaming through capillary tubes.

A fascinating opportunity for the application of rheological considerations to biology lies in the locomotor activities of animals in relation to the properties of their environment. The mechanics of flight in air and of swimming in water are subjects that have been fairly extensively studied; but the communication of Dr. G. P. Wells (London), on the habits of the lugworm (*Arenicola marina*), dealt with an example of movement in a solid medium. The lugworm lives in a more or less permanent burrow in sandy beaches and feeds by passing sand through its body. The worm lives at a depth of 20–40 cm., yet it is only the surface sand that contains any particles of nutriment. This raises the problem of maintaining a permanent 'head shaft' in the muddy sand, a problem solved by the secretion of a cement substance on the part of the worm; this cement binds the sandy wall of the shaft to a thickness of several millimetres. Not only do the mechanical properties of the beach affect the worm, but also in the course of time a colony of worms may influence considerably the properties of the beach, for example by the formation of horizontal layers of coarse-grained material from which the finer components have been sucked away. These equip the beach with an irrigation system.

The flow of blood in the vascular system has been a subject of study since Poiseuille laid the foundations of the subject by his work on the flow of water in capillary tubes. The flow of blood plasma in tubes presents no phenomena of a puzzling kind; but whole blood is an example of a suspension, and the flow of suspensions is a subject only now beginning to take shape as a rheological topic. Physiologists have had to be content hitherto to collect data in the hope that ultimately these would fall into place in some theoretical scheme. The hope is not yet realized. Prof. R. Fåhraeus (Uppsala), himself a leading authority in this field, outlined the present condition of the problem in a paper beautifully illustrated by microprojection of blood flow in glass capillaries. Prof. Fåhraeus directed particular attention to the fact that in certain pathological states the rheological properties of blood are altered in such a manner that the distribution of flow in a capillary bed may be considerably changed. Dr. J. M. Potter (London), showed a film, prepared by Dr. D. A. McDonald and himself, of the flow of blood in the basilar artery of the rabbit. This artery is formed by the fusion of the two vertebral arteries, and the two streams of blood derived from these arteries remain astonishingly independent. This was shown beautifully in the film by the injection of dyes into either of the two vertebral arteries and by temporary occlusion of either. Some of the records were made at 1,500 frames pe second, with a milli-second time-base recorded directly on the film.

Two of the papers presented to the meeting by W Boothby and G. Lundin (Lund), and by P. Eggleto (Edinburgh), dealt with the elimination of nitroge gas from the body resulting from the sudden reductio of atmospheric pressure. This physiological problem brings in rheological considerations in three ways the diffusion of dissolved gas through the tissue cell to the nearest capillary, the transport of this gas b the circulating blood, and the tendency of the gas t separate as bubbles at certain sites within the bod Prof. Boothby spoke of the measurement of gaseou nitrogen elimination by means of the 'nitrogen mete of Lilly and Anderson (a spectrophotometric tec nique of high specificity and accuracy), and of t analysis of nitrogen-elimination curves into 'pulmonary' and 'tissue' components. Dr. Eggleton referred more particularly to the diffusion of nitrogen through fatty tissues and through fats and oils (in which nitrogen is five times more soluble than in water, and through which, on account of their viscosity, diffusion is slow).

The formal programme of the colloquium contained, in all, sixteen communications. This is a very small sample of rheological topics to draw from the whole of biological science, and there is no knowing whether it was representative. The fact that three of the sixteen papers (A. V. Hill, London; F. Buchtal, Copenhagen; and O. Sten-Knudsen, Copenhagen), were concerned with the mechanical properties of muscle, was probably a fair indication, however, of the great interest aroused by this rheological problem; and the substance of these communications illustrated the degree to which this subject has passed beyond the purely descriptive exploratory phase of research into the phase of exact measurement under controlled conditions. Prof. Hill's communication has been printed in *Nature* of September 9 (p. 415), and it is sufficient here to note the interest aroused by his recent results indicating that the stretching of a muscle in the excited state may bring about some endothermic chemical reaction. If a muscle can derive chemical potential energy from mechanical work done upon it, we are far indeed from the simple rheological picture of muscle mechanics—an assemblage of springs and dash-pots—that seemed sufficient twenty years ago.

The two communications referred to above, from the Neurophysiology Department at Copenhagen, illustrated the attempt to simplify the nature of the problem by study of the mechanical properties of single muscle fibres. Buchtal and Kaiser have applied longitudinal vibrations to such individual fibres, and by electrical recording have obtained Lissajou figures on a cathode-ray oscillograph in which the x-component records the alternating applied tension and the y-component the resulting alternating changes of length. The shape of the ellipse produced is affected by the physiological conditions of the fibre and the frequency of the vibration. These authors distinguish between 'elastic stiffness' and 'viscous stiffness'. The former is determined by the resonance frequency of the vibrating system, and the latter by the ratio of load to amplitude of movement at this resonant frequency. The changes in these two dynamic properties induced by electrical stimulation, by loading conditions, by temperature, etc., were the subject of this communication.

Dr. Sten-Knudsen's paper dealt with experiments of similar nature, in which the applied force consisted of an oscillating twist instead of a tension. The response of the fibre to such torsion enables conclusions to be drawn as to the structural forces operating normally to the fibre axis.

Even the stress - strain relations of non-living natural fibres are too complicated to describe in terms of simple viscous-elastic models: Dr. F. Anderson (Copenhagen), described the phenomena of after-stretch or relaxation observable in cellulose fibres subjected to sudden strain. Such relaxation, if attributed (following Eyring and his associates) to 'flow' of cellulose molecules or aggregates, can be used to provide a description of the rheological properties in terms of molecular structure—to determine, for example, the size of the aggregates between which slip is occurring.

Perhaps the most fundamental topic discussed at the meeting was that raised by Dr. M. Joly (Paris). It concerned the structures—transient and microscopic structures—present even in many relatively simple colloidal solutions. The flow characteristics of certain colloids point to the conclusion that reversible dissociation or aggregation of particles can occur as a direct consequence of the shear in the flowing liquid. Extreme examples of such effects are displayed in the phenomena of thixotropy and of rheopexy.

In addition to the communications just described, papers were read by Dr. R. D. Preston (Leeds), on the ascent of sap in trees, Prof. A. Frey-Wyssling (Zurich), on Poiseuille flow in latex tubes, Dr. T. D. Day (Leeds), on the flow of water in connective tissue, and Dr. F. A. Glover (Reading), on the rheology of human uterine secretions; all provoked warm—occasionally heated—discussion, both in and out of the lecture hall.

The success of this colloquium—and those who had attended it appeared all to rate it highly successful—was no chance result, but directly due to the care and forethought of Prof. H. Burström and Dr. A. Deutsch, who acted as local organisers. It was an agreed policy that informal discussion should be an important part of the proceedings; but discussion cannot be brought about by decree. That discussion took place freely and fully was the result of two things. The restricted size of the colloquium made it possible for each member quickly to make the acquaintance of all others; and the provision of a buffet for meals and refreshments in the grounds of the Institute made it unnecessary for members to scatter at intervals in search of sustenance. The generosity of the Swedish Government, which placed a sum of money unreservedly at the disposal of the organisers for hospitality, made it possible to provide this refreshment free of charge, and no better way could have been found to make this hospitality effective.

The proceedings of the colloquium will be published as part of a monograph on "Rheological Problems in Biology" now being prepared by Prof. A. Frey-Wyssling (Pflanzenphysiol. Inst. d. Eidg. Tech. Hochschule, Zürich). The cost of publishing the proceedings is borne by a grant from the United Nations Educational Scientific and Cultural Organisation, to which body the organisers of the colloquium are also indebted for a grant of money towards the expenses of the meeting.

OBITUARIES

Prof. A. W. Conway, F.R.S.

ARTHUR WILLIAM CONWAY, by general consent the most distinguished Irish Catholic man of science of his generation, was born at Wexford on October 2, 1875, and died in Dublin on July 11, 1950. He was educated at University College, Dublin, and Corpus Christi College, Oxford, and was elected a junior fellow of the Royal University of Ireland in 1900 and a senior fellow in 1901. In the latter year he was appointed professor of mathematical physics in the old University College, being continued in a similar office when the new University College was created in 1909.

Conway's earliest papers, which appeared from 1902 onwards, were concerned with problems in the electromagnetic theory of light—the reflexion of electromagnetic waves from moving conductors, the propagation of light in crystals, and general properties of the partial differential equations of physics: in 1904 he made notable advances in the study of fields of force due to moving electrons. These researches led him naturally to the question of the origin of spectra. At that time (some years before Rutherford's discovery of 1911 that the atom is like a miniature solar system, or Bohr's discovery of 1913 that a spectral line is generated when an electron falls from one orbit to another), it was generally supposed that spectra were produced in the same way as sounds are produced by the free vibrations of a material body: that is to say, the atom was regarded as an electrical system of some kind, which had a large number of natural periods of oscillation, corresponding to the aggregate of its spectral lines. Conway, in a paper of only two and a half pages in the *Scientific Proceedings of the Royal Dublin Society* in 1907, was the first to break with this conception, and to enunciate the principles on which the true explanation was to be based: namely, that the spectrum of an atom does not represent the free vibrations of the atom as a whole, but that an atom produces spectral lines one at a time, so that the production of the complete spectrum depends on the presence of a vast number of atoms. In his view an atom, in order to be able to generate a spectral line, must be in an abnormal or disturbed state; and in this abnormal state, a single electron, situated within the atom, is stimulated to produce vibrations of the frequency corresponding to the spectral line in question. The abnormal state of the atom does not endure permanently, but lasts for a time sufficient to enable the active electron to emit a fairly long train of vibrations.

As compared with Bohr's paper of six years later, Conway's work falls short in two respects: first, he associated the spectral line with a single state of the atom, whereas Bohr associated it with the transition between two states; it should, however, be remembered that Conway wrote before Ritz's paper of 1908 had convinced spectroscopists that the frequency of a spectral line is the difference of two 'terms'. Secondly, he did not connect the phenomenon with Planck's quantum of action. For these reasons, Conway's theory did not prove immediately fruitful, as Bohr's did; but the very revolutionary general principles he suggested were perfectly sound, and show a remarkable physical insight.

Conway was probably the most accomplished living manipulator of the quaternion calculus: and in a number of his later papers, he showed its superiority for the formulation both of special relativity and of quantum mechanics. He had a personal devotion to the memory of its discoverer: and had a chief share in persuading the Royal Irish Academy to undertake the publication of a collected edition of Hamilton's works. For the two sumptuous volumes which have so far appeared, and which contain a great amount of matter hitherto unknown, he acted as chief editor.

Conway held the chair of mathematical physics in University College, Dublin, until 1940, when he was elected president of the College, a position from which he finally retired in 1947. He was elected a fellow of the Royal Society in 1915, and served on its Council during 1935–36; he was for terms of years president of the Royal Irish Academy and of the Royal Dublin Society, vice-chancellor of the National University, and chairman of the School of Theoretical Physics in the Dublin Institute of Advanced Studies. He was an honorary fellow of Corpus Christi College, Oxford, and received honorary degrees from the Universities of St. Andrews, Dublin, and the Royal University of Ireland. In 1939 he was appointed a member of the Pontifical Academy of Sciences.

His wife predeceased him; but he is survived by his son and three daughters.

EDMUND WHITTAKER

Dr. L. O. Howard

LELAND OSSIAN HOWARD, who died on May 1 at the age of ninety-two, was a well-known American biologist, administrator and writer, and chief of the Bureau of Entomology of the U.S. Department of Agriculture for thirty-three years. He was born on July 11, 1857, at Rockford, Illinois, and was the eldest child of Ossian Gregory Howard and his wife Lucy Dunham (Turber) Howard, of the famous Pickering family of Massachusetts from whom there also came several other men of science. He was also distantly related to Senator Jacob M. Howard, of Michigan, one of the founders of the Republican Party in the United States, and to William Howard Taft, ex-president of the United States. While still in his infancy his parents removed to Ithaca, New York. He early became interested in outdoor life and natural history, and particularly in the birds and insects. In 1873 he entered Cornell University, and, during the four years that followed, he not only made excellent progress with his studies, but also was particularly fortunate to come under the influence of some outstanding men of science, notably John Henry Comstock, S. H. Gage and the elder Agassiz, whose lectures he had the good fortune at times to attend. Perhaps most important of all, however, he came to know Prof. C. V. Riley. Riley succeeded Towend Glover as entomologist of the Federal Government, and on the recommendation of Prof. Comstock he appointed young Howard, then newly graduated from Cornell at the age of twenty-one, to be his assistant. This was the humble beginning, on November 13, 1878, of a period of Government service that continued for more than forty-nine years. In due course he was assigned to preparation of a manual on silk culture. This formed the beginning of a long series of publications that were issued year after year prepared by Howard and published under name of his chief—a practice not uncommon in those days.

Howard, when thirty-seven, was appointed chief of the Division of Entomology. It is of significance to note that when he became chief the total annual appropriation for Federal entomological work of all kinds was only 30,000 dollars; when he retired, thirty-three years later, in 1927, at the age of seventy, the annual appropriation was 3,000,000 dollars. During the ten-year period that followed from 1894 to 1904, there occurred three events that fixed the attention of the whole country upon the importance of entomological work: the first of these was the discovery of the gypsy moth in Massachusetts in 1889; the second was the discovery of the San José scale in the United States in 1893; and the third was the discovery of the Mexican cotton boll weevil in Texas in 1894. The research work performed on these problems was in addition to that on other insect pests previously being studied, and obviously required considerable additional funds and increased personnel, and these resulted in substantial growth of every phase of the organisation. In 1904 there was put into effect by Congress the plan of organisation of Federal entomological work by which separate units were established for investigation of pests affecting the various host plants, namely, field crops, fruits, truck crops, forest- and shade-tree insects, and the like. With various modifications, changes and additions made necessary over the years, essentially the same general set-up remains in effect at the present time in the Bureau. It was also on July 1, 1904, that the entomological work of the Department was raised to Bureau status.

A notable addition to the striking events of the last decade of the nineteenth century was the discovery by Ross in 1898 of the carriage of malaria by *Anopheles* mosquitoes. As a result of this and other discoveries, medical entomology became a most mportant field of investigation and demanded the intimate co-operation of pathologists and entomologists, and in all these Dr. Howard played an honourable part.

From 1896 until 1930 Dr. Howard was recognized by being given degrees from several institutions. These included the Ph.D., M.D., LL.D. and D.Sc. More than nine hundred publications came from the pen of Dr. Howard during his creative years, including not only his official reports and bulletins and a veritable stream of periodical articles, but also several books, notably "The Insect Book", 1901; "Mosquitoes", 1901; "The House Fly", 1911; "Mosquitoes of North America", 1912–17 (four vols., joint authorship with H. G. Dyar and Frederick Knab); "History of Applied Entomology", 1930; "The Insect Menace", 1931; and "Fighting the Insects: an Autobiography", 1933. In addition to all this, many home and foreign honours were conferred upon him.

J. S. WADE

NEWS and VIEWS

Commonwealth Viticultural Research Station, Merbein, Victoria

MR. FRANK PENMAN, chief irrigation officer of the State Rivers and Water Supply Commission of Victoria, has been appointed to the Commonwealth Viticultural Research Station, Merbein, and will succeed the present officer-in-charge, Mr. A. V. Lyon, when the latter reaches the retiring age shortly. Mr. Penman holds the degree of M.Sc. of the University of Melbourne, and is a fellow of the Royal Australian Chemical Institute. He has had very considerable experience in research into problems of soils and irrigation, especially in relation to vine and citrus culture, and was for many years an officer of the Department of Agriculture, Victoria.

Mr. Lyon has been in charge of the work of the Station since it was first started by the Mildura and District Research Committee in 1919. He continued in that position when the Station was taken over by the Council for Scientific and Industrial Research in 1927. The work of the Station has contributed towards the major advances that have been made in the viticultural industry of the region since the First World War. Mr. Lyon has also made a notable contribution in providing personal detailed advice to the settlers during the critical years of many irrigation settlements along the Murray.

Economics of the Family

PUBLICATION of the Report of the Royal Commission on Population has been followed by a series of papers, and the fifth volume, entitled "Memoranda Presented to the Royal Commission" (pp. 120; London: H.M. Stationery Office, 1950; 3*s.* net), which has recently been published, contains an important contribution on "The Economic Position of the Family", by Mr. J. Hajnal and Prof. A. M. Henderson. The authors of this paper, after discussing the various ways in which parents meet the extra cost of bringing up children, by comparing their expenditure with hat of childless couples having the same income, conclude, first, that at all income-levels parents have to make considerable economic sacrifices to maintain their children, and, secondly, that children in large families have a lower standard of living than children in smaller families. Even at relatively high income-levels, parents meet a large proportion of the cost of their children by reducing their own expenditure on necessaries (for example, clothing) and buying cheaper kinds of goods to satisfy their requirements (for example, food). The cost of children is not met only by spending less on luxuries. The economic position of the family has been considerably affected by the changes of conditions since 1938. It would seem that, despite the large increase of prices and incomes, the actual money cost of a child to its parents, at a low working-class level of income, is substantially unchanged as compared with the pre-war figure. The burden of two children, which at this income-level was about a third of a childless couple's income, has now fallen to one-sixth. The raising of the school-leaving age, however, has meant that the burden lasts a year longer. Other papers in this volume include several on "The Relation between Intelligence and Fertility", by Sir Godfrey Thomson and other contributors, and a special memorandum submitted by Mr. R. F. Harrod in which he advocates family endowments proportionate to income through compulsory insurance.

National Forest Park of Glen Trool

THE latest of the National Forest Park Guides (H.M. Stationery Office; 3*s.*) describes the 110,000 acres which comprise the five forests, Glen Trool, Carrick, Cairn Edward, Changue and Kirroughtree which the Forestry Commissioners have grouped to form the National Forest Park of Glen Trool. All these forests are places of great natural beauty, and it is gratifying to know that several proprietors and tenants of lands in the vicinity of the Forest Park have agreed to allow walkers to use fixed routes across their properties. These routes are indicated in the map that accompanies the guide-book, which also contains articles on the mountains, lochs and rivers by H. L. Edlin; geology by Prof. G. H. J. Daysh; plant life by Prof. J. R. Matthews; and wild animals and birds by Gavin Maxwell. J. R. Thom, conservator of forests for South Scotland Forestry Commission, describes the forests and plantations, and Andrew McCormick gives details of seventeen of the most pleasing walking routes through Glen Trool. The Gaelic derivations and English versions of the place names are enumerated by Kevan McDonald, while the Guide also contains suggestions to help newcomers to Glen Trool to find their way to and about the Park.

Experiments on the Cornish Pilchard Fishery

An account by Dr. W. C. Hodgson and Mr. I. D. Richardson of some experiments conducted on the Cornish pilchard fishery during 1947–48 is given in a recent Ministry of Agriculture and Fisheries publication (Fishery Investigations, Series 2, 17, No. 2: The Experiments on the Cornish Pilchard Fishery in 1947–48; pp. 21. London: H.M. Stationery Office, 1949. 2*s.* net). The aim of the experiments was primarily to establish whether or not the landings of pilchards can be increased or stabilized so that the canning factories may receive adequate and steady supplies of these fish in order to offset the loss of imported canned pilchards. A general survey of the fishing area between Plymouth and Mevagissey was made, employing a ring net such as is used by Scottish east-coast fishermen for herrings. The net was slightly modified, but, even so, was not quite suitable for pilchard work. Echo-sounders were used for locating the shoals, augmented on occasion by the Scottish 'feeling wire' method of fish detection. The experiments showed most convincingly the extraordinary effectiveness of the echo-sounder in locating pilchard shoals and in determining their extent and depth. With echo-sounders in use, therefore, precision fishing, in regard to both place and depth, becomes possible, with resultant increase of catches and reduction of time and expense. A number of very striking echo-sounder 'traces' of pilchard shoals is given. During the survey, opportunity was taken to make various scientific observations on the natural history and biology of pilchards in Cornish waters.

Bird Ringing in 1949

The thirteenth report of the Bird Ringing Committee of the British Trust for Ornithology shows that the ringing of a total of 57,461 birds in 1949 exceeded the previous highest total of 1939 by 1,644 (*British Birds*, 43, No. 6; June 1950). The largest single contributions to the list come from the bird observatories. Among species ringed for the first time were the black-headed bunting, rustic bunting, black-eared wheatear, greenish warbler, purple sandpiper and bar-tailed godwit, while starlings were successfully ringed at roosts in Trafalgar Square by members of the London Natural History Society.

Individual recoveries of special interest include the first from abroad in the case of the lesser redpoll, two ringed as nestlings in the north of England having been reported in Belgium. A reed-warbler and a roseate tern, both recovered in September in Douro Province, Portugal, were also the first of their species to be reported from abroad. A linnet ringed as a nestling in Leicestershire and recovered in October at Cuenca, Spain, and a meadow-pipit ringed as a nestling in Fife and recovered in December at Mazagan, western Morocco, represent the most southerly records for ringed birds of these species. A record of a starling, ringed in Sussex in early November and recovered at Bordeaux three weeks later, is the first of its kind, and suggests a bird of different native origin from most of the winter visitors to Britain of this species. Fast travelling was shown by a wheatear ringed in Skokholm in August and recovered in Landes, France, two days later, while longevity was shown by a teal ringed in Northern Ireland and shot near Lisbon in its eleventh year.

The Amsterdam Naturalist

In Holland, as elsewhere, the number of scientific journals intended for specialists is very large, while most of the popular publications are often of little interest to the more scientifically minded. Members of the staff of the Zoological Museum, Amsterdam, have therefore decided to produce a monthly journal of real scientific standing adapted to meet the needs of the general reader. The journal has been called *The Amsterdam Naturalist*, and the first issue appeared in April 1950. In this issue are articles on the emperor penguin by K. H. Voous, a re-diagnosis of the fish genera *Wannostomus* and *Pœcilobycon* by J. J. Hoedeman and tumours in whales by A. Stoik; the journal also contains a section of notes and news. All articles are in English, and contributions to future issues are invited from biologists and naturalists. The annual subscription is 16*s.*

Preparation of Scientific Papers

A pamphlet, entitled "General Notes on the Preparation of Scientific Papers" (pp. 26. London: Cambridge University Press, 1950. 2*s.* 6*d.* net), has been prepared by a subcommittee of the Information Services Committee of the Royal Society, under the chairmanship of Prof. G. L. Brown, as the outcome of concern expressed at the Royal Society's Scientific Information Conference in 1948 about the quality of scientific papers presented for publication. The pamphlet is of a general nature and is concerned with the presentation rather than with the writing of scientific papers. It is intended to supplement and not replace those specific instructions to authors which are issued by many societies and other publishing bodies, and it emphasizes a number of points in the latter instructions to which authors should pay stricter attention. Some sections of the pamphlet should also be of assistance to typists copying papers, and some of the sections, such as those dealing with nomenclature, symbols and abbreviations, conveniently bring together the sources of reference. The final section consists of a short bibliography which might, with advantage, be extended, for the books on writing, in particular, are too limited.

Forecasting Potato Blight

A recent study by Dr. John Grainger ("Forecasting Outbreaks of Potato Blight in West Scotland", *Trans. Brit. Myc. Soc.*, 33, 82; 1950) amplifies the suggestions of Beaumont (*Trans. Brit. Myc. Soc.*, 31, 45; 1948) that a minimum temperature over 50° F. and a minimum relative humidity over 75 per cent for forty-eight hours in succession would provide a suitable climate for an outbreak of potato blight within fifteen to twenty-two days. Dr. Grainger finds it necessary to specify a "zero time" (the end of June for south-west Scotland) before which such predictions would be invalid. Little correlation between the amount of foliage blight and yield could be demonstrated, although a postscript to the paper suggests that later work reveals a considerable tota loss of as much as 25 per cent. A relationship appeared between the rate of development of foliage blight and the amount of blight appearing on the tubers. Years of slow development of the diseas on the foliage were found to result in higher tube infection and *vice versa.* There was also a tendency towards an increased proportion of ware-sized tubers in years of slow development of blight on the foliage.

Flanged Steel Plug Valves for the Petroleum Industry

British Standard 1570 (1949), which bears the title "Flanged Steel Plug Valves for the Petroleum Industry" (pp. 31; London: British Standards Institution, 1949; 7*s.* 6*d.* net), has recently been issued. It is based on American Petroleum Institute Standard 600*B* dealing with the same subject and has the advantage, therefore, of ensuring interchangeability between American and British equipment. This specification covers the design and manufacture of flanged steel plug valves, materials involved, workmanship, dimensions, appropriate tests, marking, inspection, preparation and dispatch, and also form of manufacturer's guarantee. Appendixes are provided giving details of the materials to be used. Included are drawings of plug valves and end-flange facings as required by the various classes of valves dealt with.

Application of Ultrasonics

The May issue of the *Proceedings of the Physical Society* (63B, 305; 1950) contains a summary, by Dr. G. Bradfield, of the National Physical Laboratory, of the proceedings of the symposium on the applications of ultrasonics held by the Acoustics Group on February 18, 1949. Recent advances in the investigation of the fundamental structure of matter, telecommunications and allied applications, and the use of mechanical forces set up by intense waves were surveyed. The derivation of elastic constants of substances using single crystals was considered an important field of investigation. With regard to suitable sources of ultrasonic power, the importance of barium titanate as a powerful and strongly coupled piezo-electric transducer was pointed out. Calculated optimum frequencies for propagation over various distances with minimum attenuation for various gaseous and liquid media are in accord with those found experimentally in echo-sounding, earth exploration and in propagation in metals. The success of various applications of ultrasonics in industry and in navigation was discussed, and attention was directed to the present lack of industrial application of intense waves, though many spectacular laboratory experiments have been performed with them. It would appear that it is more profitable to use ultrasonic waves for irreversible actions such as killing bacteria, cleansing, dislodging oxide films, removing dissolved gases and the precipitation of aerosols.

St. Ives Research Station of the Board of Greenkeeping Research (1929-50)

The twenty-first anniversary of the St. Ives Research Station at Bingley, Yorkshire, of the Board of Greenkeeping Research was celebrated by a series of functions, at the Station, during September 14–16. The first two days were devoted to golf courses and sports grounds, respectively, and attendance was restricted to representatives f affiliated clubs and other organisations; Lord Brabazon of Tara, past president of the English Golf Union, opened the celebrations on Septemer 14, and Mr. A. Brook Hirst, chairman of the Football Association, those on September 15. On he third day the proceedings were open to the general public, who were afforded the opportunity of seeing at first hand the many ways in which the Station is helping to achieve the best possible playing conditions in all sports using turf (see *Nature*, July 1, p. 22). There was a series of exhibits illustrating the development of the Station's research and investigational work during the past twenty-one years, the growth of the advisory service and the educational facilities made available by the Board; and short lectures and practical demonstrations were also given, together with a display of modern turf machinery and implements.

Fuel Cell at the British Association Exhibition

In an article on "Energy in the Service of Man", describing the recent exhibition at Birmingham in connexion with the meeting of the British Association (*Nature*, September 2, p. 386), it is stated that the fuel cell exhibited was constructed by the British Coal Utilization Research Association; this is incorrect. The exhibit consisted of experimental hydrogen cells constructed in the Research Laboratories of the British Electricity Authority, with ancillary apparatus. The cells are of the type:

H_2 (silver-active carbon) | aqueous KOH | (nickel-active carbon) O_2

and are modified versions of that constructed in the U.S.S.R. by O. K. Davtyan ("Direct Conversion of Chemical Energy of Fuel into Electrical Energy", Moscow, 1947: Academy of Sciences, U.S.S.R., 48 pp.). One of these cells was shown in operation, but it has not been possible in preliminary experiments to obtain outputs as high as those claimed by Davtyan. This simple type of cell serves to demonstrate the principle of fuel-cell action, but in order to obtain worthwhile current densities, more elaborate constructions would probably be required, such as the high-pressure cell developed by the Electrical Research Association. Even so, the high cost of hydrogen at present would make it uneconomic, so that future research must be directed towards the evolution of a cell operating on a cheaper fuel, such as water, gas, or better, coal itself. In this connexion, a diagram of a cell constructed in the laboratories of the British Coal Utilization Research Association (McKee, J. H., and Adams, A. M., *Fuel*, 28, 1; 1949) was shown. This employs carbon as fuel and operates at a high temperature, but for various reasons its overall efficiency is low.

United Kingdom Postgraduate Awards

Published by the Association of Universities of the British Commonwealth, the Universities Yearbook for 1949–50 contained *inter alia* two useful appendixes; one describing postgraduate awards tenable at universities in the United Kingdom, and the second containing a short list of some of the more important awards tenable by British graduates overseas. In accordance with a resolution at the Congress of Universities of the Commonwealth in July 1948 that each country in the Commonwealth should prepare a list of postgraduate and research awards tenable at its universities by students, the Association of Universities of the British Commonwealth has reprinted these appendixes as a separate booklet. In the first Appendix the awards are set out clearly under different subject headings to indicate those which are open to graduates of United Kingdom universities, those which are open to graduates of British universities overseas, as well as awards which are open to graduates of universities outside the British Commonwealth. The booklet may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Royal Astronomical Society: Dublin Meeting

THE Royal Astronomical Society is to hold a meeting in the rooms of the Royal Irish Academy, Dublin, during September 21–23. An ordinary meeting for the discussion of papers will be held on September 22. A discussion on problems of solar physics, some of which will be concerned with matters relating to the forthcoming solar eclipse, has been arranged by the Dunsink Observatory, and will be held on September 21, under the chairmanship of Prof. H. B. Brück. On September 23 there will be a Geographical Discussion on "Planetary Atmospheres". A popular lecture, arranged by the Royal Astronomical Society in co-operation with the Irish Astronomical Society and University College, Dublin, will be given by Sir Harold Spencer Jones in University College, Dublin, on September 22; Sir Harold will speak on "Time". There will be a reception at Iveagh House by the Minister of External Affairs on September 21, and excursions to Dunsink and Armagh Observatories and to other places have been arranged.

Building Documentation Conference, Paris

THE first general assembly of the International Council for Building Documentation will meet in Paris, at the invitation of the French Government, during October 23–28. Subjects for discussion will be: exchange of abstracts and information; terminology; classification; format and lay-out of publications; data sheets; the needs of the users of information. The United Kingdom delegation and observers will be nominated by the British Building Documentation Committee (Secretariat: Ministry of Works Library, Lambeth Bridge House, London, S.E.1), from whom further particulars may be obtained.

Joint Commission for Spectroscopy

THE Joint Commission for Spectroscopy, the purpose of which is to promote and co-ordinate original research in atomic and molecular spectra, is a joint commission of the International Union of Pure and Applied Physics and of the International Astronomical Union. It was formed in 1949 and consists of twelve members, six drawn from each of the two Unions. It is under the auspices of the International Council of Scientific Unions and is supported by Unesco subventions. The first meeting of the Commission will be held in conjunction with the Faraday Society Conference on "Spectroscopy and Molecular Structure" which will take place in Cambridge during September 25–28 (see *Nature*, July 15, p. 97). On the three evenings of September 26–28 the Commission will hold technical discussions in Trinity College. On September 29 a short symposium will take place in the Cavendish Laboratory. All who are interested in the work of the Commission are invited to participate. Lodgings, etc., may be reserved through the Secretary of the Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1. The provisional secretary of the Joint Commission for Spectroscopy is Prof. C. J. Bakker, Zeeman-Laboratory, Pl. Muidergracht 4, Amsterdam-C, The Netherlands.

Announcements

PROF. L. JÁNOSSY, senior professor in charge of the Cosmic Ray Section of the Dublin Institute of Advanced Studies, has accepted an invitation to a professorship in the University of Budapest (his native town). He was formerly at the University of Manchester, and moved to Dublin in March 1947. He left for Budapest on August 11.

LORD DERBY will open the new laboratories of the British Hat and Allied Feltmakers Research Association at Stanley House, Manchester Road, Fairfield, Manchester, on September 19 at 11.30 a.m.

THE ninety-fifth annual exhibition of the Royal Photographic Society was opened by Mr. L. V. Chilton on September 14 in the Society's House, 16 Princes Gate, London, S.W.7 (close to the Albert Hall); the exhibition is open to the public, without charge, until October 15 from 10 a.m. to 8 p.m. (Saturdays, 10 a.m.–5.30 p.m.; Sundays, 2.30–5.30 p.m.).

THE tenth series of postgraduate lectures, arranged by the Oil and Colour Chemists' Association, will be held this year at Manchester (at Cheetham Town Hall, Cheetham Hill Road, Manchester 8) on September 29, October 6 and October 13 at 6.30 p.m., when Dr. A. S. C. Lawrence will give a course of three lectures on "Topics in Colloid Science". The fee for the course is 10*s*., and applications for tickets should be made to Mr. John Hannaford, Secretary and Treasurer, O.C.C.A., Aldwych House, Aldwych, London, W.C.2.

A SCIENTIFIC conference on milk production, to be held in Paris during November 28–30, is being organised by the Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation. The conference will follow the lines of those on bread and on food fats held in 1948 and 1949 respectively. The programme is in three sections: production and genetics; production and feeding; and pathology and hygiene of production. Further particulars of the "Journées Scientifiques de la Production du Lait" can be obtained from the Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation, 71 Boulevard Péreire, Paris (17^e).

A SUMMER school on electrical resistance strain-gauge methods, organised by the University of Cambridge Engineering Department jointly with the Stress Analysis Group of the Institute of Physics, will be held in Cambridge during September 25–30. The school will be run on the same lines as those held in 1948 and 1949, and its purpose is to provide graduates in engineering, physics or allied subjects, who have not previously used such strain gauges, with the introductory theory to the subject and practical instruction. Further particulars and application forms may be obtained from the honorary secretary of the Stress Analysis Group, Mr. E. K. Frankl, Engineering Laboratory, Trumpington Street, Cambridge.

ERRATUM. In the communication entitled "Thermal Decomposition of Potassium Perchlorate" in *Nature* of July 15, p. 109, column 2, line 4 from bottom, for "nitrate" read "chlorate"; the formulæ below the graph should be $KClO_4$ and not $KClO_3$ as printed.

POST-TETANIC POTENTIATION OF RESPONSES OF MOTONEURONES

By Prof. J. C. ECCLES, F.R.S., and W. RALL
Department of Physiology, University of Otago, Dunedin, New Zealand

RECENTLY, Lloyd[1] has shown convincingly that after repetitive stimulation of afferent fibres from muscle there is a large potentiation of all reflex effects (excitatory or inhibitory) directly produced by impulses in those fibres. Since this post-tetanic potentiation is not associated with an increased excitability of the motoneurones as tested either by a synergic afferent volley or by an antidromic volley, it must be agreed with Lloyd that it is restricted to the specific *presynaptic* pathway that has been tetanized. We have recorded post-tetanic potentiation after a much wider range of conditioning tetani than were used by Lloyd[1] and also have made a detailed survey of the immediate post-tetanic period. Our experiments give general confirmation of Lloyd's observations and provide in addition many data relating to the time course of development of post-tetanic potentiation and to the effects of variations in duration of the conditioning tetanus. These results will be fully reported elsewhere. The present communication concerns the application of post-tetanic potentiation to the experimental testing of two hypotheses relating to synaptic transmission.

(1) It has been postulated[2,3] that presynaptic impulses act on motoneurones by generating thereon local areas of depolarization (local responses), which, if sufficiently dense, will spread and fuse to form, eventually, an impulse that is propagated down the axon (the reflex discharge). If the synaptic stimulation is inadequate in intensity or the anæsthesia deep enough, the local responses will fail to spread and be propagated, and then merely generate the slow negative potential (called the synaptic potential) that is recorded either focally by a micro-electrode close to the motor nucleus, or after electrotonic spread along the motor axons to the emerging ventral root[4]. Even when there is a reflex discharge, it may be seen to supervene on a brief rising phase of synaptic potential. According to the above hypothesis of synaptic excitatory action, during post-tetanic potentiation the testing presynaptic volley must evoke an increased synaptic potential, for both synergic and antidromic tests show that the excitability of the motoneurones is not increased (cf. above).

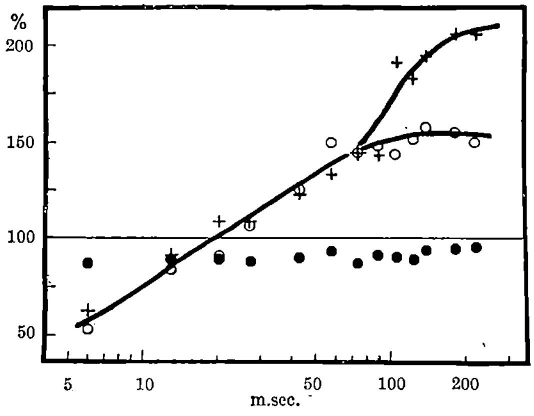

Fig. 1. After a conditioning tetanus of 50 volleys at 300 a sec. (quadriceps nerve as afferent), a test volley in that nerve was set up at the intervals indicated by the abscissæ (logarithmic time-scale). The sizes of focal presynaptic spikes (closed circles), focal synaptic potentials (crosses) and ventral root synaptic potentials (open circles) are plotted as percentages of the respective mean control values (cf. Fig. 2 for method of measurement). The additional rise in the focal synaptic potential beyond 100 m.sec. is due to the spike potentials of the potentiated reflex discharges, which were also seen with the ventral root records, but did not there complicate the measurement

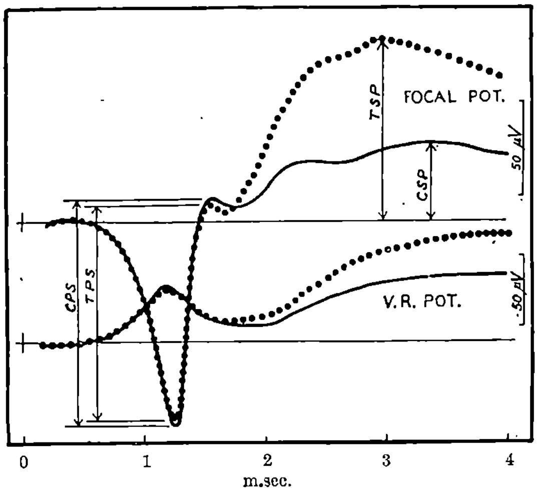

Fig. 2. Each curve is drawn as the mean of four closely similar records which were enlarged by projection. The continuous line shows the control records, while the line of circles gives the test response at 165 m.sec. after a conditioning tetanus of 100 volleys at 300 a second. C.P.S. and T.P.S. represent control and test presynaptic spike, respectively; C.S.P. and T.S.P. represent control and test synaptic potential, respectively, of the focal record. These records were obtained under conditions of deep anæsthesia in order to eliminate reflex discharge

On experimental test, it has invariably been found that post-tetanic potentiation of the reflex spike discharge is closely correlatable with the potentiation of the synaptic potential recorded either focally (cf. ref. 1) or from the ventral root. For example, Fig. 1 shows that immediately after a brief conditioning tetanus there is an identical development of focal and ventral root synaptic potentials from an initial depression to a potentiation, which, when large enough, is associated with a reflex spike discharge. Furthermore, these two types of synaptic potential begin synchronously (within 0·05 msec.) at 0·35–0·5 msec. after the arrival of the presynaptic volley at the synaptic knobs[4], and each is potentiated right from its onset (Fig. 2).

It may be concluded that the experimental tests are in close accord with predictions from the above hypothesis, and provide further evidence (cf. ref. 4) that the potentials recorded focally and from the ventral root are generated by the same synaptic excitatory process.

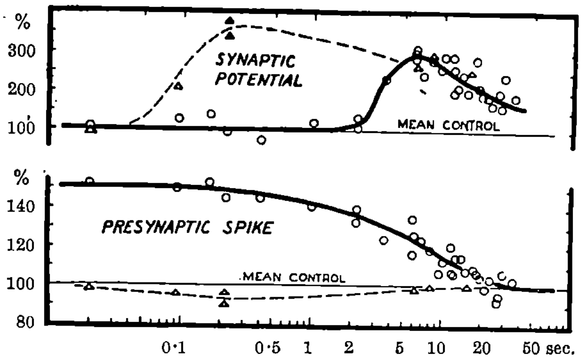

Fig. 3. Plotting as in Fig. 1, but (circles) after a much longer conditioning tetanus (3,000 volleys at 300 a sec.). Triangles show a few observations of the same experiment with conditioning by 50 volleys at 300 a sec. (cf. similar curves in Fig. 1). Note logarithmic time-scale

(2) It has been postulated[1,5] that post-tetanic potentiation is caused by an increase in size of the presynaptic impulses. This hypothesis is based on the general observation that the size of conducted impulses is supernormal in axons which, in their recovery from previous activity, are passing through the phase of after-positivity. Confirmation of this hypothesis requires the observation both of supernormality of presynaptic impulses after tetanus, and the parallelism between such supernormality and potentiation in the subsequent postsynaptic response. Both these observations have been made by Lloyd[1], as shown in his Figs. 13 and 14. However, in our experiments, only after the most severe tetani (10 sec. at 300 a sec.) was there, in part, the parallelism recorded by Lloyd (Fig. 3). The differences may be attributable to differences in technique. For example, we have set up our conditioning and testing volleys in the nerve to quadriceps muscle (the appropriate ventral roots being severed), whereas Lloyd has stimulated dorsal roots. Further, we have recorded both the presynaptic spike and the synaptic potential with a micro-electrode close to the quadriceps nucleus, and have used the synaptic potential as a measure of the potentiation. Thus, in Fig. 2 the initial diphasic spike (C.P.S. and T.P.S.) gives a measure of the presynaptic spike size, while the subsequent synaptic potential has been measured relative to the initial base line as shown (C.S.P. and T.S.P.). Since Lloyd only tested at 2·4-sec. intervals, he may have missed the initial post-tetanic period in Fig. 3, where maximal presynaptic potentiation gives no postsynaptic potentiation. Such a discrepancy between presynaptic and postsynaptic responses might be attributable to an initial post-tetanic depression of the motoneurones. However, at long post-tetanic intervals there is also a discrepancy, for a considerable postsynaptic potentiation remains despite the disappearance of all presynaptic potentiation (circles, Fig. 3). When progressively shorter conditioning tetani are used, the presynaptic–postsynaptic discrepancy becomes so great that no correlation whatever is possible. After 2 sec. at 300 a sec. there is still some correlation; but, with conditioning tetani of 50–100 volleys (Fig. 1 and also the few records indicated by triangles in Fig. 3), no presynaptic potentiation is observed—indeed, there is depression —and yet there is always a large postsynaptic potentiation, which builds up to a maximum in 100–200 msec. (Fig. 1, cf. also the plotted records of Fig. 2). Such observations make untenable the hypothesis that explains post-tetanic potentiation simply in terms of presynaptic potentiation[1,5]. In general, there must be some other explanation for post-tetanic potentiation, though presumably, when presynaptic potentiation exists, it contributes to the post-tetanic potentiation (cf. the concurrent decaying phases at test intervals of 6–30 sec. in Fig. 3).

The most probable postulate for post-tetanic potentiation in general is that the presynaptic impulse becomes a more effective synaptic excitor because repetitive stimulation temporarily alters the spatial relationship of the synaptic knobs to the postsynaptic membrane; for example, the knobs may become larger and/or in closer apposition thereto. It is to be noted that the post-tetanic facilitation process is approximately 30,000 times longer in duration[1] than the facilitation that is attributable to depolarization and increased excitability of motoneurones[3,4,6], and thus is more likely to be related to those prolonged functional changes in the nervous system that occur in conditioned reflexes, and which presumably depend on some change in the form or structure of the synapse. [April 6.

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ORALLY ADMINISTERED ANTIBIOTICS AND THE VENEREAL DISEASES

By R. R. WILLCOX

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THE venereologist now has four potent antibiotics —penicillin, streptomycin, aureomycin and chloramphenicol—perhaps capable between them of curing all the venereal diseases. Penicillin and streptomycin are usually administered by parenteral injection; but aureomycin and chloramphenicol exert their greatest effect when given orally. Streptomycin is ineffective when given by this route although oral penicillin is sometimes used. This article considers the present status in venereology of aureomycin, chloramphenicol and oral penicillin.

Chancroid

Wetherbee *et al.*[1] found that *H. ducreyi* is not particularly sensitive *in vitro* to penicillin or aureomycin. Personal experience, however, indicates that both aureomycin and chloramphenicol, administered to volunteers simultaneously with inoculation of chancroidal matter, will prevent the appearance of soft sore[2]. Zheutlin and Robinson[3] successfully treated three patients with clinical lesions with 2 gm. of aureomycin given orally for 7–14 days. Greenblatt *et al.*[4] consider that 5–10 gm. of chloromycetin will likewise cure chancroid. Oral penicillin also has some action; but the variable concentrations obtained in the blood do not give it any advantage over other drugs.

All three of these antibiotics are anti-syphilitic, and may, therefore, mask an undetected syphilitic infection without necessarily curing it completely, and none should be employed for chancroid as a routine. Sulphonamides, which do not mask syphilis, are the drugs of election. Although single injections of streptomycin, as given for the treatment of gonorrhœa, have no effect on the dark-field positive lesions of early syphilis[5], the larger doses given for chancroid, in which condition it is very successful, may do so[6]. Streptomycin may, therefore, be reserved for sulphonamide-resistant cases and aureomycin for streptomycin-resistant cases.

Gonorrhœa

All three of the antibiotics given orally are capable of curing gonorrhœa, although their action is less certain than that either of penicillin or streptomycin given by the parenteral route. Likewise all are anti-syphilitic, and, as with treatment with parenteral penicillin, a follow-up of six months is necessary.

87 per cent of 122 cases of gonorrhœa given 1·0–3·5 gm. of aureomycin orally were considered cured by Collins *et al.*[7]. Previously Finland *et al.*[8] claimed 49 out of 66 cured, and Willcox and Findlay[6] had success with two cases. Willcox[9] likewise had success with two cases treated with chloramphenicol, as did Greenblatt *et al.*[4] on a larger if still small series.

With oral penicillin Jacoby and Ollswang[10], employing 400,000–600,000 units in buffered tablets, had 223 cures out of 270 treated males and 18 cures in 23 females. Such a method has been under trial for some years; but the dangers of self-medication and under-treatment cannot be overlooked. It has recently been applied to the U.S. Navy as a prophylactic. Campbell *et al.*[11] found, by giving 200,000 units orally fifteen hours after exposure, that the incidence of gonorrhœa could be reduced by half. Eagle *et al.*[12] divided 350 sailors into two groups. On return from a 6–8 hour shore leave half were given 100,000 units in a buffered tablet and the remainder acted as controls. In twenty-four weeks there were 43 cases of gonorrhœa in the controls but only five cases in sixteen weeks in the treated group. The dose was then increased to 250,000 units and, in the next eight weeks, only one additional case was reported.

Granuloma inguinale

4,000 mgm. of aureomycin personally given to four patients over five days was not sufficient, for two cases relapsed[13]. Greenblatt *et al.*, who in 1948 recommended a dose of 5,000 mgm. over five days[14], increased this in 1949 to 20 gm. given over ten days and had satisfactory results in 16 cases treated[15]. There seems to be some difference of opinion, however, as to whether aureomycin is effective for granuloma nguinale when given intramuscularly. Greenblatt *et al.*[14] say no and Wright *et al.*[16] yes. Robinson *et al.*[17] found it a less satisfactory drug than streptomycin, although Greenblatt *et al.* found it efficient for treptomycin-resistant cases[14].

With chloramphenicol Willcox[9] had temporary uccess with one case, and Greenblatt *et al.*[4], giving 00 mgm. six-hourly, treated 34 patients with only wo relapses. Thus, whatever the outcome of this early work, it will be noted that both these newer ntibiotics have the power to reinforce streptomycin, hich has already wrought such a dramatic change n the treatment of this erstwhile distressing condition hich does not respond to penicillin and but tardily o the antimonials.

Lymphogranuloma venereum

Although this condition is to some extent influenced by penicillin[18], this influence is reduced if the oral route is employed, and such is not recommended. Aureomycin was reported as effective by Wright *et al.*[16,19], who had considerable success in 35 patients treated. I used it on one case in Southern Rhodesia, a native with large bilateral, tender, non-fluctuant buboes and slight œdema of penis and scrotum but in whom the Wassermann and Kahn tests were negative; there were no genital sores. The Lygranum skin test was positive and the Dmelcos test negative. He was given 250 mgm. aureomycin orally three times daily for two days and then twice daily for three days (total 3,000 mgm.). By the fourth day the œdema had disappeared, and by the fifth day the glands were no longer tender and the patient was discharged from hospital.

Robinson *et al.*[20], however, state that when aureomycin was administered intramuscularly in doses of 0·56–3·6 gm. over 4–15 days, or orally as 3·6–38 gm. over 5–15 days, there were disappointing results in nine patients. Greenblatt *et al.*[4] likewise had only four cures in 13 early cases treated, but in late cases with proctitis some benefit was noted if the treatment was continued for 37–60 days. The same authors found chloromycetin inferior to aureomycin in eleven cases treated, and it seems likely, therefore, as in the treatment of chancroid, that the sulphonamides should have first place in this condition also.

Non-Specific Urethritis

Penicillin, given orally or otherwise, is relatively ineffective, and sulphonamides remained the drugs of choice until streptomycin became available, and this drug is producing fair results. Aureomycin, however, also has some action. Finland *et al.*[8] treated two persons successfully with 9 and 11 gm. respectively. Willcox and Findlay[6] treated four patients with 1–2 gm. over 1–2½ days with response in three, one of which relapsed but responded to retreatment.

Syphilis

O'Leary *et al.*[21] had healing of lesions in two patients with early syphilis given 44·2 and 67·5 gm. of aureomycin orally. The same authors[22] also noted involution of nodulo-ulcerative gummata in two other patients. Irgang and Alexander[23], giving 1 gm. intramuscularly for 20–23 days, and Willcox[5], employing relatively small doses of 750–1,500 mgm. orally over 24–48 hours, observed the abolition of *T. pallidum* from the dark field and the rapid healing of lesions in nine patients. That aureomycin has some action upon syphilis is undoubted, although Moore[24] considers it inferior to penicillin.

Employing chloramphenicol, Robinson *et al.*[25] found that *T. pallidum* disappeared from the lesions of primary and secondary syphilis in an average of 33·4 hours when 1 gm. was given six-hourly to a total of 40 gm. Two patients observed for more than a month became sero-negative. Romansky *et al.*[26] treated 32 patients with early syphilis with 8–56 gm. of chloramphenicol divided into four-hourly doses over 4–6 days. The dark fields became negative in 22–28 hours and the healing of lesions was prompt. Only two had been observed for two post-treatment months; but three had reached sero-negativity and others were improving. Of four Bantu Negroes personally treated with 1·75–3·0 gm. given orally, the lesions healed in an average of 6·25 days with a rapid disappearance of treponemata[9].

Oral penicillin has, from time to time, been used experimentally for syphilis. The dose necessary is certainly extravagant, and the inconsistencies of absorption render such a method too risky for a serious disease like syphilis, and the parenteral route should be adopted. However, it has some indications, as for weakly babies with infantile congenital syphilis, until such a time as a more robust treatment can be instituted, and for rare cases as hæmophiliacs in whom needle puncture is contra-indicated. Buerk and Tucker[27] treated one such orally with 48 mega units.

Choice of Drugs

Under present conditions of knowledge, and granting that all are readily available, the drugs of choice for the different venereal diseases would appear to be as follows: the second drug listed to be used for persons failing to respond to the first.

Disease	First	Second
Chancroid	Sulphonamides	Streptomycin
Gonorrhœa	Systemic penicillin	Streptomycin
	Streptomycin	Systemic penicillin
Granuloma inguinale	Streptomycin	Aureomycin
Lymphogranuloma venereum	Sulphonamides	Aureomycin
Non-specific urethritis	Streptomycin	Aureomycin
Syphilis	Systemic penicillin	More penicillin

Thus, at present, the newer oral antibiotics are second-choice drugs. It is probable, however, on account of their multi-natured action, that they possess enormous prophylactic potentialities which will, doubtless, in due course be explored.

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ROLE OF TRYPTOPHANE AND OTHER AMINO-ACIDS IN THE METABOLISM OF NICOTINIC ACID BY HUMANS

By W. I. M. HOLMAN and D. J. de LANGE

South African Institute for Medical Research, Johannesburg

ALTHOUGH an increased urinary output of N-methylnicotinamide has been observed after ingestion of tryptophane by the rat[1], and also by humans[2,3], the rate of excretion does not appear to have been studied closely. Ling *et al.*[4] have, however, reported that the total pyridinenucleotide content of the erythrocytes of rats increased as early as four hours after intravenous injection of tryptophane, and reached a peak after eight to ten hours.

We have recently determined the rates of excretion of N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide by an adult male European of thirty-four years during eight successive 3-hour periods after the ingestion of 3 gm. l-tryptophane, and have compared the results with those obtained in similar experiments on the same subject after no treatment (control experiment), or after ingestion of 100 mgm. nicotinamide or 100 mgm. nicotinic acid. In each experiment (except the control), the dose was taken at 7 a.m. as an aqueous solution, and urine specimens were collected at 3-hour intervals thereafter. The subject consumed his customary diet, which was kept reasonably constant, although the food was not weighed out; meals were taken at 7.30 a.m., 1.30 p.m., 7.15 p.m. and 9 p.m. The experiments were carried out on four consecutive Tuesdays, in the order shown in Table 1. N-methylnicotinamide was determined by the method of Huff and Perlzweig[5], and N-methyl-2-pyridone-5-carboxylamide by that of Holman and de Lange[6].

The results of the control experiment show that there was no great variability in the rate of excretion of either metabolite during the course of the day, and that the excretion of pyridone was more constant than that of N-methylnicotinamide.

After ingestion of l-tryptophane, the rates of excretion of both metabolites were higher in all eight periods than in the corresponding control periods. The conversion of tryptophane to nicotinic acid therefore appears to have commenced within three hours after the dose. Since the subject had received a dose of nicotinamide in the interval between the control and tryptophane experiments, the results were checked by repeating the experiment on the same subject four months later, the subject having received no treatment with nicotinic acid derivatives in the meantime, and the tryptophane being given on the day following the control experiment. Similar results were obtained, but the increase in the rates of excretion of both metabolites was not so pronounced in the first 3-hr. period.

The experiment was also carried out on another subject (a female of thirty-six years) who had previously received no extra-dietary supplies of nicotinic acid. In this case the rates of excretion of both metabolites were increased in the first 3-hour period; but the increase in pyridone was relatively small (N-methylnicotinamide increased from 0·15 to 0·38 mgm./hr. · N-methyl-2-pyridone-5-carboxylamide

Table 1. *NMN* = N-methylnicotinamide ; *P* = N-methyl-2-pyridone-5-carboxylamide

Experiment	Metabolite of nicotinic acid	Average rate of urinary excretion of metabolite (mgm./hr.) in 3-hr. period No. 1	2	3	4	5	6	7	8
Control	*NMN*	0·33	0·26	0·32	0·22	0·28	0·15	0·26	0·29
	P	0·57	0·60	0·58	0·61	0·67	0·61	0·48	0·61
Nicotinamide (100 mgm.)	*NMN*	5·7	1·9	1·05	0·48	0·38	0·33	0·45	0·43
	P	4·6	5·1	3·9	3·4	2·9	2·27	1·67	1·60
1-Tryptophane (3 gm.)	*NMN*	0·45	0·57	0·42	0·40	0·30	0·20	0·34	0·36
	P	0·97	1·23	1·65	1·29	1·53	1·35	1·10	1·16
Nicotinic acid (100 mgm.)	*NMN*	1·06	1·12	0·58	0·56	0·53	0·48	0·60	0·54
	P	1·37	2·11	1·90	2·04	1·92	1·53	1·36	1·27

from 0·21 to 0·29 mgm./hr.). In the case of a third subject (a male of twenty-eight years), who had received 100 mgm. nicotinamide a week before the experiment, there was a slight increase in the rate of excretion of N-methylnicotinamide in the first 3-hour period (from 0·21 to 0·33 mgm./hr.), but none in that of the pyridone. The second and third subjects showed large increases in the rates of excretion of both metabolites in the second 3-hr. period after tryptophane. These results indicate that there may be appreciable variability between apparently healthy individuals in the rapidity of conversion of tryptophane to metabolites of nicotinic acid.

In general, however, the results for the three subjects show that the rate of excretion of at least one metabolite was increased, in some cases considerably, within three hours after ingestion of tryptophane, suggesting that the process occurs, at least initially, in the tissues and not through the agency of the intestinal flora.

Further examination of Table 1 shows that the rates of excretion of the urinary metabolites of nicotinic acid in the first four, compared with those in the last four, periods were much higher after nicotinamide than after nicotinic acid or tryptophane. This suggests that, if all three compounds are equally readily absorbed, the amidation of nicotinic acid is an important factor controlling the production of metabolites of nicotinic acid from tryptophane.

It seemed of interest to study the effect of amino-acids other than tryptophane on the metabolism of nicotinic acid by humans. Considerable evidence is available[7-11] that the growth-rate of rats receiving a diet low in casein and deficient in nicotinic acid may be suppressed by the addition of proteins or protein hydrolysates containing little or no tryptophane, or by mixtures of pure amino-acids. No corresponding depression of the urinary excretion of N-methylnicotinamide was, however, observed[9,10]. The growth suppression could be remedied by the addition to the diet of nicotinic acid or tryptophane.

We have determined the urinary excretions of N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide by humans before and after the ingestion of a relatively large dose of a tryptophane-free protein hydrolysate. Two healthy adult European subjects (No. 1 a female aged thirty-six years, No. 2 a male of thirty-four years) were given a constant diet consisting of everyday foods, of similar composition to that described in an earlier experiment[12]. The urinary excretions of the metabolites of nicotinic acid were determined in three consecutive 48-hour control periods. At the commencement of the next (fourth) 48-hour period each subject was given a supplement of 100 gm. of acid-hydrolysed casein ('Difco' casamino-acids). Analysis of the hydrolysate showed that it contained only traces of nicotinic acid and tryptophane (nicotinic acid 0·6 mgm./100 gm. ; tryptophane 7 mgm./100 gm. by the method of Millon[13], 75 mgm./100 gm. by the method of Folin[13] ; NaCl, 13·4 per cent ; total N, 10·9 per cent). The dose was taken in aqueous solution at intervals over a period of several hours. The levels of excretion of N-methylnicotinamide and N-methyl-2-pyridone-5-carboxylamide were determined during the fourth, fifth and sixth 48-hour periods. The results are shown in Table 2.

Table 2. *NMN* = N-methylnicotinamide ; *P* = N-methyl-2-pyridone-5-carboxylamide

Subject No.	Metabolite of nicotinic acid	Urinary excretion (mgm.) of metabolite of nicotinic acid in 48-hour period No. 1	2	3	4	5	6
1	*NMN*	8·2	6·9	7·2	6·4	8·8	5·1
	P	13·9	12·2	12·6	9·0	16·6	10·7
2	*NMN*	15·5	14·2	15·0	13·0	10·5	16·9
	P	34·3	34·1	33·8	29·4	30·1	36·3

It is clear that no increase in the levels of excretion of the metabolites of nicotinic acid occurred after the dose, indicating that acid-hydrolysed casein contains no amino-acid which has any important effect in increasing the body's supplies of nicotinic acid. There was, in fact, a slight, but consistent, fall in the levels of excretion in the fourth period, suggesting that the amino-acids may have had a suppressing effect on nicotinic acid metabolism.

However, the alternative possibility, namely, interference with absorption or with intestinal biosynthesis of nicotinic acid, cannot be excluded, because of the nauseating nature of the dose of amino-acids and its possible disturbance of the normal gastro-intestinal rhythm. The whole dose was ingested by each subject, however, in addition to the basal diet.

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FIFTIETH ANNIVERSARY CELEBRATIONS OF THE DISCOVERY OF RADIUM

THE fiftieth anniversary of the discovery of radium was celebrated, albeit two years late, by a series of meetings held at the École Supérieure de Physique et de Chimie de la Ville de Paris during July 16–20. The delay, engendered by post-war difficulties, was more than excused by the successful conduct of the occasion and the liberality of the hospitality extended to the wide circle of foreign men of science who were present.

The celebration began with a ceremony on July 16 at which Prof. L. de Broglie presided, attended on either side by the Curies' daughters, Irene and Eve. The audience was welcomed by the director of the college, Prof. R. Lucas, who paid tribute to the part played in the organisation of the function by M. G. Boreau, the president of the association of old students of the college, and by Prof. G. Champetier. Prof. de Broglie reviewed the scientific achievements of the Curie family, beginning with the earlier successes of Pierre Curie in the fields of piezo-electricity, the theory of crystal symmetry and of magnetism. The brilliantly successful, but all too short, period of collaboration with the Polish student, Marie Sklodowska, whom he married, was recalled, and the subsequent development of the science of radioactivity and the part played by their daughter Irene was briefly narrated. Prof. F. A. Paneth replied for the visitors, analysing the historical aspects of the discovery. M. Boreau, a student of the college during the years 1897–1900, welcomed delegates from scientific societies from all over the world and announced the receipt of telegrams from many others. Speeches were also delivered by Mme. Ferragi (Institut du Radium, Paris) and Prof. G. Champetier (Ecole Supérieure de Physique et de Chimie).

Following the ceremony, the audience attended the unveiling of a plaque, commemorating the discovery of radium by Pierre and Marie Curie with the assistance of Gustave Bemont, that had been affixed to the entrance to the college.

The delegates were entertained to a dinner on July 18, held on the first platform of the Eiffel Tower, and on the morning of July 20 many of them visited the laboratories of the Commissariat à l'Energie Atomique, which are at Fort Chatillon, just south of Paris.

The opening ceremony was followed by three colloquia, each lasting a day, during July 17–19. The first dealt with the formation of ions, excited molecules and radicals in liquids by ionizing radiations and with their distribution. F. A. Paneth (Durham) described work in progress in his laboratory on a new determination of the curie by measurement of the volume of helium formed in a measured time by a measured mass of radium in an aqueous solution of a radium salt. Lauriston Taylor (National Bureau of Standards, United States) reported some recent investigations with carbon disulphide, ligroin and other liquid-filled ionization chambers. L. H. Gray (London Hospital) reviewed the columnar theory of ionization, and, by the combination of this hypothesis with the free-radical hypothesis of indirect action in irradiated aqueous solutions, he drew conclusions as to the distribution and concentration of the radicals and the hydrogen and hydroxyl ions in irradiated aqueous solutions. Another aspect of this problem was considered by F. S. Dainton (Cambridge), who showed how the kinetics of polymerization, induced by the irradiation of aqueous solutions of a monomer, will distinguish between uniform and non-uniform radical distribution. The session was concluded by a report of P. Jordan (Zurich) on the effects of mechanical recoil, following various neutron-induced nuclear reactions, when the irradiated material is in finely powdered form.

The second symposium was focused on the protection afforded by competitive reactions in irradiated media. N. L. Whitehead, C. Goodman and J. A. Breger (Massachusetts Institute of Technology), in a paper presented by the last-named author, discussed the decomposition of films of the fatty acids by the alpha-particles from radon and its relation to chain-length ; the relevance of the investigation to the problem of the mode of formation of natural petroleum was briefly discussed. M. Burton described some results obtained in collaboration with S. Gordon and R. R. Hentz (University of Notre Dame, Indiana), concerning the effect of alkyl substitution on the decomposition of benzene derivatives by X-radiation. A. Nightingale (Guy's Hospital, London) presented some preliminary results obtained by C. B. Allsopp (Guy's Hospital) on the X- and γ-irradiation of aqueous solutions of indole, and C. H. Collie and P. Shaw (Oxford) described the precautions necessary for the successful application of the Szilard–Chalmers concentration to the measurement of low neutron intensities by means of the alkyl halides. The morning session concluded with an analysis by W. Mund (Louvain) of the effects of ionizing radiations on the reaction between hydrogen and deuterium and the influence of foreign gases thereon.

The afternoon session was opened by a paper by M. Haissinsky and M. Lefort (Institut du Radium, Paris) on the effect of ionizing radiations on solutions of various oxidizing and reducing agents. Some effects in formic acid solution were described by A. H. W. Aten, jun. (Amsterdam), and J. Weiss (Durham) presented a variety of experimental results relating to effects in organic substances, particularly in aqueous solutions. F. H. Krenz (Edinburgh) discussed some theoretical aspects of the mechanism of indirect action in aqueous solutions. A. G. Maddock and J. H. Green (Cambridge) showed how the inefficiency of bond rupture following radiative thermal-neutron capture could be determined, and advanced a hypothesis explaining their results. The close analogy between the chemical effects of ionizing irradiations and ultrasonic irradiation of aqueous solutions was demonstrated by N. Miller (Edinburgh), and W. M. Dale (Manchester) emphasized the insufficiency of present physico-chemical hypotheses to explain the biochemical effect of ionizing radiation.

The third symposium concerned the production, prevention and recovery of radio-lesions. S. Rowlands (Edinburgh) described the irradiation of the stomach mucosa of dogs with phosphorus-32, and F. Ellis (London Hospital) compared the results of fractionation of X-irradiation of the skin. The mechanism of the action of ionizing radiations on yeast cells was examined by C. A. Tobias (Berkeley, California), and M. Lamarque (Montpellier) presented a study of the recovery of the eggs of the death's head moth following irradiation by X-rays. Z. M. Bacq, A. Herve and M. Betz (Liège) gave an account of the protective effect of sodium cyanide and azide.

The afternoon session opened with a paper by R. H. Mole (Atomic Energy Research Establishment, Harwell) on the possibility of protection, by chemical means, from whole-body irradiation. G. Hevesy (Stockholm) described some applications of tracers to the study of radio-lesions, and A. Forssberg (Stockholm) followed with a tracer study of the problem of protection from X-radiation. E. Lorenz (Bethesda, United States) presented a hæmatological study of the recovery of guinea pigs following chronic exposure to γ-radiation. The session closed with some further consideration of the problem of protection by L. F. Nims (Upton, United States).

A. G. MADDOCK

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ANNUAL CONGRESS

AS part of the diamond jubilee celebrations of the foundation of Salisbury, Southern Rhodesia, the 1950 congress of the South African Association for the Advancement of Science was held there, during July 3–7, in conjunction with the Rhodesia Scientific Association. The meeting was most successful, and was attended by more than one hundred visitors from the Union as well as by men of science from both the Rhodesias. The Sociedade de Estudos, Mozambique, was also represented. Visitors were well entertained by the town of Salisbury, by the Governor and by the Rhodesia Scientific Association, and a number of excursions were arranged covering most of the varied interests of those present at the congress.

In his presidential address to the Association, Prof. C. van Riet Lowe, director of the Union Archæological Survey, spoke on "Prehistory and the Humanities", making a plea for the wider teaching and study of prehistory as a means for emphasizing the essential unity of mankind and inducing a better appreciation of spiritual values.

The sectional address to Section A of the Association, by Mr. W. J. Jarvis, dealt with "Planning from a Multi-Racial Aspect" and considered some of the problems involved in integrating the native population into an introduced Western way of life. To Section B, Dr. A. M. Macgregor spoke on "The Primary Source of Gold", suggesting that gold mineralization is related to the intrusion of granitic material into basaltic rocks from which traces of gold are dissolved and concentrated. Dr. E. R. Roux spoke to Section C on "Interspecific Plant Hybrids" and cited examples of hybridization between apparently different genera which closer investigation shows might be merely very different adaptations; more studies on hybrids are needed. The address to Section D dealt with "Aspects of Museum Research", in which Mr. Reay H. N. Smithers, director of the National Museum, Bulawayo, showed the value of taxonomic studies in museums and urged the need for expansion of these services, which are basic to other biological researches. To Section E, Mr. Roger Summers, also of the National Museum, described "Iron Age Cultures in Southern Rhodesia", dealing particularly with the many ancient ruins and proposing a tentative chronology for them and for the Iron Age pottery found in the country.

Following the suggestion made by the United Nations Educational, Scientific and Cultural Organisation, a symposium was held on the theme of "Man's Use of Energy". An outstanding contribution was the first authoritative account of the plan to dam the waters of the Zambesi River at the Kareba Gorge, some two hundred miles below the Victoria Falls, and to set up power plants to develop about one million kVA. The dam would also make possible a big irrigation project.

Particular interest was aroused in the popular evening lecture—always a feature of the yearly congress—which this year was given by Dr. S. H. Skaife, of Cape Town, and included a colour film showing the activities of termites which he has kept for fifteen years in specially designed and constructed nests. The life-cycle of the insects was traced, and many new sidelights thrown on the totalitarian regime of these creatures, which were seen on the screen at very large magnifications.

THE NATURALIST IN THE FIELD TO-DAY

THE Nature Conservancy is now in being and is a potential check against the destruction of areas in Great Britain of special importance from the point of view of geological structure, vegetation or other wild life, or of scenic beauty. The widespread seizure of these areas for afforestation, agriculture, Service requirements, etc., makes it all the more imperative to preserve what is left. But reserves can never be administered effectively by remote committees—still less from a 'window in Whitehall'. The care and vigilance of local interests, and especially of local naturalists, is needed: How far are they competent to shoulder this responsibility? This question formed the subject of the presidential address by Dr. E. A. R. Ennion to the Conference of Delegates of Corresponding Societies at the recent meeting at Birmingham of the British Association.

Dr. Ennion, as warden of Flatford Mill Field Centre, has devoted the past five years to devising ways and means whereby the 'amateur naturalist', irrespective of age, sex, background or calling, can gain increasing competence in his or her special interests. The experimental stage is almost ended.

There has been a steady rise, growing steeper in post-war years, in the 'curve of opportunity' open to the amateur naturalist. Dr. Ennion discussed some of the contributory factors in turn: books and journals; natural history society reports; lectures, with the improved technique now offered by various visual aids; films; broadcasts. But all these have one fundamental weakness—the recording of someone else's triumphs and experiences. Only by personal exertions and discoveries is anyone really able to become a naturalist.

The opportunities for first-hand experience and guidance in field-work have increased considerably, although mainly for two groups: the university student, who has facilities especially for marine work at Plymouth, Millport, Port Erin, etc.; and the ornithologist, at any of the small coastal bird observatories, Skokholm, Lundy, Spurn Head, etc. A trend towards establishing inland stations is growing, too: Oxford at Wytham; Cambridge at Madingley; and the narrow boat *Beatrice* of the Severn Wildfowl Trust are instances in point.

Much still remains to be done in at least three directions: (*a*) provision for field-work other than marine (or freshwater) biology and ornithology; (*b*) ensuring effective linkages between the various branches; and (*c*) provision for the guidance and reception of the individual inexpert but potentially serious student.

Flatford Mill, where Dr. Ennion took his first students in May 1946, and the three other centres of the Council for the Promotion of Field Studies—Dale Fort, Juniper Hall and Malham Tarn—go part of the way towards filling these deficiencies. Each accepts between forty and fifty students a week from March to October (and a few in the winter) from universities, training colleges and schools all over Britain, together with a "fair leavening of independent naturalists and artists". Each is staffed by a warden and his assistant, who cover all branches between them, the warden also being responsible for the entire organisation of his centre—an exacting post but a very much alive and worthwhile one.

A thousand university students and five hundred older independent visitors come to these field centres in the course of the year, which leaves about four thousand vacancies, distributed between the four centres, for teachers, training-college students and sixth-form boys and girls, whose previous experience of field-work is very limited. Almost all of them need the full-time co-operation of the warden and his assistant. So there is very little chance of adequate help for the occasional student—"the one in every twenty-five or so who takes to field-work like a duck to water"—who would obviously respond keenly to individual attention.

But these occasional individuals are of prime importance: they are the amateur naturalists of the future. Dr. Ennion is leaving his post at Flatford Mill to establish a new station, the Farne Naturalists Trust, where it will be possible to welcome these students individually. Monks' House, south of Bamburgh and opposite the Farne Islands on the Northumberland coast, has been secured for this purpose. It is designed expressly for the amateur naturalist, more particularly perhaps for the ornithologist, although workers in many other branches will find ample opportunity and a ready welcome. Monks' House opens next Easter, and details will be available shortly for those who are interested in this new development.

NEW ZEALAND EARTHQUAKES DURING 1947–48 AND JULY–DECEMBER 1949

R. C. HAYES has examined and catalogued all earthquakes in New Zealand during 1947[1] and also 1948[2]. In 1947 the earthquakes of June 16, from lat. 38·4° S., long. 178·4° E., and of October 13, lat. 44·2° S., long. 169·0° E., attained intensity 7 on the Modified Mercalli scale, and six earthquakes attained intensity 6. The sea area between the two islands and its environs, and North Island east and north-east of the River Wanganui, had the majority of the epicentres. There were concentrations of epicentres to seaward off Gisborne, and in the Southern Alps west of Christchurch and north-east of Mount Aspiring; also a small group to seaward in the extreme south off Puysegur Point. Otherwise, throughout the year, there were very few earthquakes elsewhere.

In 1948, 127 earthquakes were reported as felt during the year. The largest disturbance occurred on May 23 in the Hanmer–Waiau region, when intensity 8 on the Modified Mercalli scale was reached. Some buildings in the epicentral region suffered structural damage, and minor activity continued at intervals for some months. Other strong shocks occurred on January 15 off the Manawatu coast, on June 19 off the west coast of the South Island, and in July in the Monowai region; the first two of these were widely felt.

Provisional seismological bulletins for July–December 1949 have been received from the Dominion Observatory, Wellington. They include readings from nine observatories, including Suva, Fiji, and a new station, Cobb, established on July 20, 1949, in lat. 41° 5′ S., long. 172° 44′ E., and equipped with a Wood–Anderson short-period seismograph east–west component. During the period 114 strong distant earthquakes were recorded, and 129 local shocks felt. Of shocks with instrumental magnitude 5 or greater which were felt, three were experienced in Opotiki, three in Tolaga Bay, one each in Wairoa and New Plymouth and several in Wellington.

[1] New Zealand Seismological Observatory Bulletin *S*-90 (1949).

[2] *ibid.*, *R*-34 (1949).

STANDARDS FOR TELEVISION SYSTEMS

ONE of the study groups of the International Consultative Committee on Radiocommunication (C.C.I.R.) has recently been exploring the possibility of obtaining international agreement on the standardization of some of the various technical factors which define the characteristics of a television system. A preliminary meeting was held at Zurich in July 1949, at which it was decided that, before meeting again in London in 1950, the study group should inspect the practice and present state of development of the existing television services in America and Europe (see *Nature*, 164, 477; 1949).

This inspection was carried out by representatives of some sixteen national administrations and operating organisations, and started with a visit to the United States in March and April of this year. The programme comprised a series of visits in New York, Philadelphia and Washington, D.C., for the purpose of witnessing the present-day operation of the television services available in the eastern portion of the United States, the development and production of various types of television equipment, and particularly of observing demonstrations specially arranged to assist the study group in its work on standards for television. This was followed by visits to Paris and Eindhoven, where the arrangements and demonstrations were organised by the Radiodiffusion et Télévision Françaises and the N. V. Philips Gloeilampenfabrieken, respectively. Finally, in Great Britain the delegates visited various stations and establishments of the British Broadcasting Corporation and the General Post Office, and industrial laboratories and factories. In all cases, the visits and demonstrations were designed to show the present state of television development and the different aspects of the varied and detailed work which is necessary for the establishment and maintenance of a public television service.

This tour was followed by a meeting of the study group in London during May 8–12, at which the various aspects of television standardization were discussed with the view of facilitating the interchange of programmes between countries and of reducing to a minimum the possibility of interference between television transmissions in adjacent countries. It was concluded at this meeting that, while it would have been most desirable to achieve standardization on a world-wide basis on all the various characteristics which define a television system, this appears to be impossible because of the existence of public television services using different standards in several countries in which large numbers of receivers are already in the hands of the public. There was, however, unanimous agreement on the following points, which were recommended for approval by the next plenary assembly of the International Consultative Committee on Radiocommunication : (1) television systems should be capable of operating independently of the frequency of the power supply ; (2) the aspect ratio of the picture should be 4 : 3 ; (3) line interlacing should be used in the ratio 2 : 1 ; (4) asymmetric side-band transmission should be adopted for the vision signal ; and (5) there is no necessity to standardize the polarization of the radio transmission.

In addition to the above, the characteristics of the 405-, 525-, 625- and 819-line systems were examined in some detail ; and, for the reasons already stated, the representatives of France, the United Kingdom and the United States confirmed the continued use of their present standards. The French and United Kingdom delegates maintained their previous proposal, made at Zurich, to consider the unification of the standards of the London and Paris television transmitters. At the same time, the representatives of Austria, Belgium, Denmark, Italy, the Netherlands, Sweden and Switzerland declared themselves in favour of the 625-line system, and addressed an appeal to their colleagues to reconsider the position. The meeting concluded by directing attention to a number of technical problems that need further study in connexion with the general subject of television standardization.

ZOOLOGY IN RELATION TO AGRICULTURE*

By Dr. D. STEWART MacLAGAN
West of Scotland Agricultural College, Glasgow

ZOOLOGY *in sensu stricto* is the science of animal-life ; agricultural zoology deals with the application of zoological knowledge to the practice of farming. The prospective adviser or research worker in agricultural zoology must, therefore, have a comprehensive knowledge of the vast terrestrial fauna, and must also be sufficiently informed about agriculture to assess the potentialities of zoological discoveries in relation to farming practice. Reasoned conjecture is part of the stock-in-trade of the academic biologist (and is usually harmless) ; but the agricultural biologist must be more circumspect. As with other applied sciences, agricultural zoology is based on a tripod of supporting struts—education, research, and its application—and, from the teaching point of view, one should steer a course between pure academics and sheer utilitarianism.

Few people cannot be aroused to enthusiasm over some aspect of animal life, and the countryside abounds in a wealth of teaching material. In the past, there has been a tendency to lay undue emphasis on structural details, at the expense of the ecological approach to zoology ; although for all but the specialist student the ecology of animals has usually a greater appeal, and is certainly of great value in linking up with other subjects. This implies greater attention to the study of animals as a product of their environment—the effects of climatic and edaphic factors, the significance of natural enemies and other natural factors of population control, the causes of animal plagues, and so on. Apart from the educational value of zoology there is an urgent need of obtaining a deeper insight into the role of animals in the economy of Nature, because of sheer economic necessity.

In Britain to-day, there are six million more people and three million fewer acres of good farmland than there were in 1914 ; which means that there is only about half an acre of productive land per person. Now, every piece of land has a series of practical ceilings of productivity which can be raised by reducing the effectiveness of limiting factors, such as herbage-eating rodents, beasts and birds of prey, plant-feeding insects, disease-carrying ticks, and parasitic worms of stock and crop. Since there are no large areas of land awaiting easy exploitation, an alternative means of alleviating the food situation is the intensification of production ; but all forms of intensive culture favour the multiplication of pests and insect-borne diseases, as seen in the abundance of orchard, vegetable and glasshouse pests : eelworms of potato, beet and oats, and virus diseases of plants.

Through the operation of numerous 'checks and balances', plants, plant-feeders, and their natural enemies exist in a state of fluctuating equilibrium—the balance of Nature—until man starts to cultivate the soil or heavily stocks the ground. Thereafter, the complex relationships which contribute to the balance are ruptured in varying degrees, with resultant increase of some species and reduction of others. Heavy stocking favours the spread of disease-causing parasites. Bare fallowing reduces the soil population, whereas continuous monoculture favours a dense and specialized fauna. Between these extremes, different rotations favour different pests ; but, in general, the farmer has a powerful weapon for pest-control in the judicious choice of rotations.

In view of the causal relationships between pest-densities (population) and environmental conditions, the agricultural zoologist has a splendid opportunity of linking science with practice, and of simultaneously expounding many highly relevant biological themes, for example, the struggle for existence and the survival of the fittest, the reproductive potential of animals and the toll of the environment, predator-prey relationships, adaptive modifications of structure and function, hazards of the parasitic mode of life, etc. Surviving species have adjusted themselves, in the course of time, to their environment (including competition among themselves) and have become the warp and woof of an intricate pattern. Hence, to assess the true role of a species in the economy of Nature is an exacting task, requiring a fundamental knowledge of ecology in general.

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* Substance of an address to a Conference on the Land and the School, arranged by the Association of Agriculture in conjunction with the University of Glasgow and the West of Scotland Agricultural College, July 11–14.

LETTERS TO THE EDITORS

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O—H Absorption in Chelate Compounds

It is well known that many benzenoid compounds containing a COOH- or-OH-group *ortho* to another group capable of forming an internal hydrogen bond do not exhibit the normal OH-band found in simple unassociated hydroxylic bodies. The nature of the OH-absorption in intramolecularly bonded substances has never been clearly demonstrated, although some isolated examples of interest have been given[1-5]. It is the purpose of the present communication to provide general ideas regarding the OH-absorption of some chelate bodies, based on new data, and also to point out a certain similarity with the double COOH-ring found in associated acids.

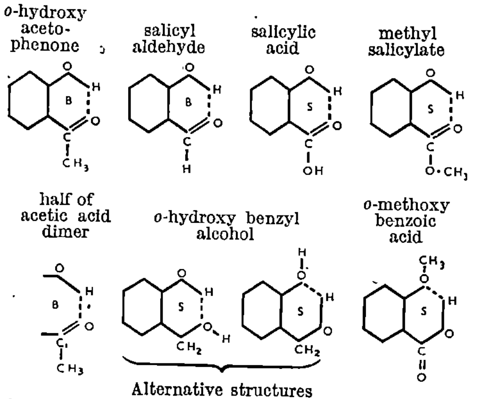
Fig. 1 shows the absorption spectra in the 3-μ region of some carboxylic acids and related substances in carbon tetrachloride solution. Where no concentration is given, the absorption is substantially independent of the strength of the solution.

The spectra of methyl benzoate and anisole are given to indicate the amount of absorption attributable to a phenyl group (3·20–3·38 μ) and to a methyl group (dominant bands close to 3·39 and 3·52 μ; cf. 3·376 and 3·482 μ in paraffins[6]).

Acetophenone and *o*-hydroxyacetophenone show a rather striking suppression of CH_3-absorption. This may be compared with the reduced intensity of absorption of CH_3 when adjacent to a C=C group in hydrocarbons[6].

Stearic acid and *m*-methoxybenzoic acid are normal and show the usual increase in strength of the monomeric OH-band as the solution is diluted. Very intense CH_2-bands at 3·417 and 3·503 μ are found for stearic acid (cf. 3·418 and 3·505 μ for paraffins[6]).

Salicylic acid is of considerable interest. Apart from the monomeric OH-absorption (from COOH only) at 2·83 μ, the intense absorption at longer wave-lengths is clearly the sum of two separate effects. The band at 3·1 μ, similar to that found in methyl salicylate[4], is independent of concentration and therefore arises from intramolecular bonding, whereas the broad absorption band extending from 3 μ to beyond 3·6 μ is sensitive to concentration changes and arises from double molecules, as with other carboxylic acids (cf. acetic acid[7]). That an equilibrium between single and double molecules of salicylic acid of the form $R.COOH + R.COOH \rightleftharpoons 2(R.COOH)$ really does exist can readily be deduced from intensity measurements obtainable from Fig. 1.



B denotes broad OH band; *S* denotes sharp OH band
Fig. 2

Salicylaldehyde and *o*-hydroxyacetophenone both give broad bands extending from 2·8 μ to beyond 3·4 μ, but with a considerably smaller intensity than is given by carboxylic acids. Salicylaldehyde also has a sharp band at 3·521 μ attributable to the CH of the aldehyde group, and another small band at 3·641 μ of unknown origin.

o-Hydroxybenzyl alcohol has a sharp monomeric OH-band at 2·775 μ, as well as a fairly sharp band at 2·91 μ, due presumably to intramolecularly bonded OH, and somewhat similar to that found in *o*-methoxybenzoic acid[3]. The C_6H_4- and CH_2-groups absorb normally.

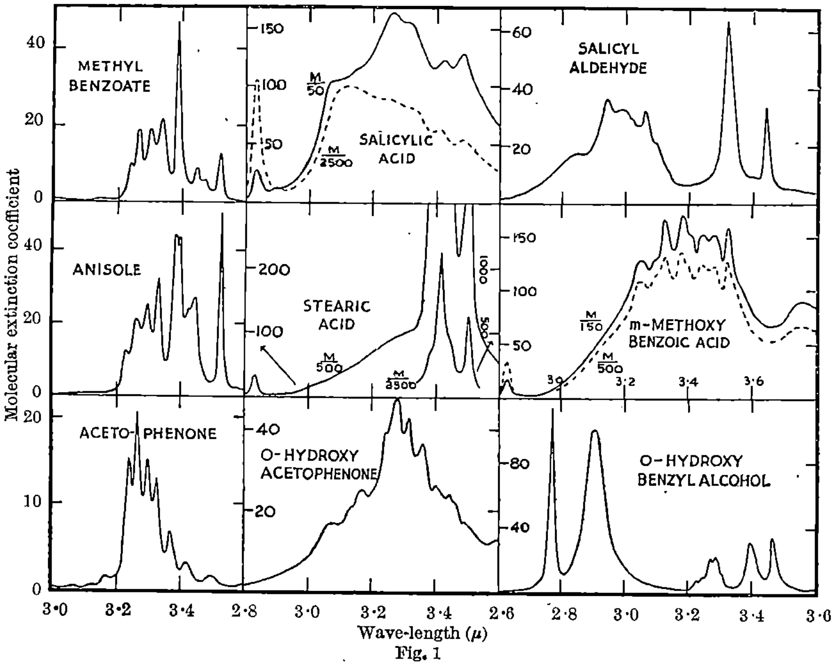
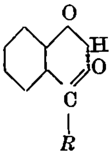


Fig. 1

From these various spectra three facts regarding OH-absorption emerge: (1) carboxylic acids at a concentration of *M*/50 or higher are almost completely associated and have intense OH-absorption starting at 2·83 μ and extending well beyond 3·6 μ; (2) some hydroxylic bodies exemplified by salicylaldehyde and *o*-hydroxyacetophenone exhibit broad OH-bands as found in the acids, but with about one-fifth of the intensity of absorption; (3) other hydroxylic bodies also capable of intramolecular hydrogen bonding possess a fairly sharp OH-band at 2·9–3·1 μ, quite different from the absorption mentioned in (1) and (2). These results are summarized in Fig. 2, and it is immediately obvious that a broad band is associated with the structure where *R* is H or CH_3, but a sharp band is produced when *R* is OH or $O.CH_3$. With *o*-methoxybenzoic acid and *o*-hydroxybenzyl alcohol, the C=O group in the ring containing the hydrogen bond is replaced by C—O, and a sharp band results.



It is of interest to note that one-half of the dimer of acetic acid (Fig. 2) is very similar to part of the ring containing the hydrogen bond in *o*-hydroxyacetophenone, and the OH-absorption is much the same in the two cases, although that of the carboxylic acid has about three times greater intensity.

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Structure of Dimethyltriacetylene

Crystals of pure dimethyltriacetylene[1], $H_3C—C{\equiv}C—C{\equiv}C—C{\equiv}C—CH_3$, sealed in a Lindemann glass tube, are sufficiently stable at room temperature for detailed X-ray analysis. The crystal structure has the space-group $R\bar{3}m$ with one molecule in the rhombohedral unit cell. The centro-symmetrical molecule lies with its eight carbon atoms extended along the triad axis, and four parameters suffice to define their positions completely. These parameters have been determined by a Fourier synthesis of the $(h0\bar{h}l)$ structure factors; the atomic centres were located by the differential method with application of termination-of-series corrections[2]. The standard deviation of the bond-lengths is at present estimated to be 0·015 A., and it is hoped that further work now in progress may increase the accuracy of the analysis. The bond-lengths obtained are compared with those from related molecules in the accompanying table.

Bond-lengths in Acetylenic Molecules

Substance	$-C{\equiv}C-$	$\equiv C-C\equiv$	$\equiv C-CH_3$	Method
Dimethyltriacetylene	$1\cdot19_5$ A.	$1\cdot38_0$ A.	$1\cdot46_5$ A.	X-ray
Acetylene	1·204	—	—	Spect.[3]
Methylacetylene	—	—	1·462	Spect.[4]
Dimethyldiacetylene	1·20	1·38	1·47	Elect. diff.[5]
Diacetylene	1·19	1·36	—	Elect. diff.[5]
Diphenyldiacetylene	1·18	1·39	—	X-ray[6]
Diacetylenedicarboxylic acid	$1\cdot18_5$	1·33	—	X-ray[7]

The triple bond-lengths in this table show very close agreement. The lengths of the conjugated single bonds, which are of particular interest because of their anomalous force constants in diacetylene and dimethyldiacetylene[8], appear to vary considerably, and unless this bond is unusually sensitive to environment our measurement is inconsistent with the value reported for diacetylene-dicarboxylic acid[7]. The value for the hyperconjugated single bond-lengths in the dimethyltriacetylene is the same within experimental error as the spectroscopic value for methylacetylene.

We wish to thank Prof. E. G. Cox for suggesting this investigation and providing the necessary facilities; we are indebted to Prof. E. R. H. Jones, Dr. M. C. Whiting and Mr. J. B. Armitage for supplying the material and advising us on handling it. We also wish to acknowledge a Ministry of Education grant to one of us (J. S. R.).

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Raman Effect of the Isomers of Benzene Hexachloride

In the course of our research programme on the structure of molecules, we have photographed the Raman lines of the pure alpha, beta, gamma and delta isomers of benzene hexachloride ($C_6H_6Cl_6$) dissolved in benzene. The lines were photographed with a Steinheil *GH* three-prism spectrograph specially fitted for Raman work (collimator, f = 195 mm.; camera, f = 255 mm.). The lines were excited by the mercury line 4358 A. by means of a Heræus No. *S*700 lamp.

The following Raman lines of the pure isomers were observed:

Alpha: 285, 310, 340, 400, 555, 655, 710, 795, 860 cm.$^{-1}$
Beta: 265, 305, 375, 390, 555, 670, 730, 855 cm.$^{-1}$
Gamma: 325, 345, 390, 485, 860, 690, 785, 890 cm.$^{-1}$
Delta: 300, 475, 555, 755, 790 cm.$^{-1}$

Of these the following frequencies were selected, the intensities of which were not influenced by the solvent: 710 (alpha), 730 (beta), 690 (gamma) and 475 cm.$^{-1}$ (delta), and were used for the determination of the isomer content of an industrial product. The intensities of these lines, which were measured on a Leeds and Northrup microphotometer, were compared with one another and with a suitable benzene line.

The preliminary experiments have shown that it is possible to estimate the isomer constitution of technical benzene hexachloride (with an accuracy of about ± 4 per cent) by means of the Raman effect.

A more complete description will be given elsewhere of the preparation of the pure isomers, the analysis procedure, the structure of the $C_6H_6Cl_6$ molecule and of a characteristic intensity and frequency change observed in mixtures.

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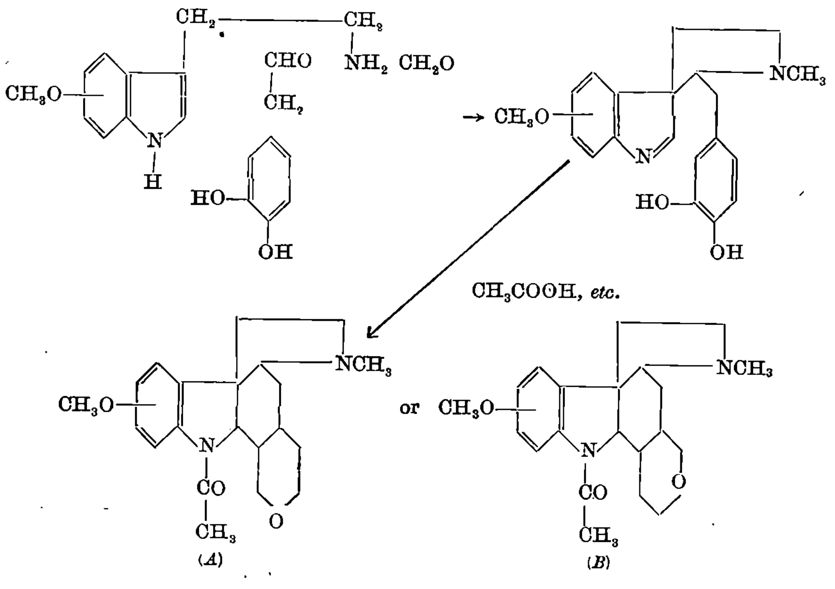
A New *Strychnos* Alkaloid

As part of a survey of the chemical constituents of the Australian flora, we have examined the alkaloids of *Strychnos psilosperma* F. Muell. Leaves collected at Dalmar, near Rockhampton, contained approximately 1 per cent total alkaloid from which a new alkaloid, now named 'strychnospermine', was readily isolated. It formed colourless needles of melting point 209°, had $[\alpha]_D + 58°$ ($c = 2{\cdot}07$ per cent in chloroform), and analyses of it, its bromo-derivative (m.p. 245°), its hydrochloride (m.p. 330–332° with decomp.) and its picrate (m.p. 254° with decomp.) indicated the formula $C_{21}H_{28}O_3N_2$. Tests for a methylene-dioxy group were negative, but one methoxyl and one methylimino group were present. When a small crystal of potassium dichromate was added to its solution in cold concentrated sulphuric acid, an intense permanganate colour was immediately produced. Treatment of the alkaloid with methyl iodide at room temperature readily gave a methiodide (m.p. 335° with decomp.), showing the presence of a tertiary nitrogen atom. Strychnospermine could not be hydrogenated in acetic acid solution in the presence of palladium charcoal. Hydrolysis with acid or alkali yielded deacetylstrychnospermine (m.p. 222°), which was smoothly reconverted to the parent alkaloid by acetic anhydride. The deacetyl derivative gave with nitrous acid a pale yellow crystalline nitroso compound (m.p. *c.* 195° with decomp.). The remaining oxygen atom is inert and is presumably in an ether linkage.

The evidence so far obtained, although slight, supports the hypothesis that strychnospermine is structurally related to the alkaloids of the strychnine group. Recently, Woodward[1] (cf. Goutarel[2] *et al.*) has advanced a theory of the biogenesis of these alkaloids, the application of which to strychnospermine leads to the deduction of the structural formulæ shown below.

The following points should be noted: (*a*) the rupture of the carbocyclic ring and the subsequent formation of the six-membered ether ring involve the loss of a carbon atom, whereas in strychnine a seven-membered ring is formed without the loss of a carbon atom; (*b*) at present formulæ *A* and *B* appear equally probable; (*c*) the reaction between the primary amino-group and formaldehyde (or its equivalent) leads to simple methylation and not to the formation of a new ring as in strychnine; (*d*) acetylation of the cyclic nitrogen atom is also simple, and again there is no subsequent formation of a new ring as in strychnine.



Work on the structure of strychnospermine is in progress, and it will be of interest to determine whether these predictions have any validity.

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Filter-Paper Chromatography: Extraction of Sugars from the Paper at Room Temperature

In the procedure for the quantitative analysis of sugars, described by Flood, Hirst and Jones[1], the paper strips containing the sugars are cut out and extracted by allowing condensed water to run down the paper. It has been found, however, that destruction of certain sugars occurs on boiling a solution under these conditions. To obviate this difficulty, we have devised a technique of extraction at room temperature similar to that used by Dent[2] for amino-acids.

A chromatogram run with water as solvent indicated that the sugars travelled down the paper almost at the solvent front, and that the first few drops of eluate contained all the sugar from the paper strip. Similar results were obtained when water from a capillary was allowed to flow slowly down the paper (see below). On the other hand, however, it was found that if the rate of flow from the capillary were appreciably increased at the initial stage, there was risk of incomplete extraction due to channelling of the water flow.

The procedure finally adopted was as follows. The paper strip, pointed at the lower end to facilitate dropping, was held between two glass rods the interior surfaces of which were ground flat, and water was introduced to the top of the paper by means of a capillary dropping tube. This tube (capacity 10 c.c.; dropping-rate when full, 1 drop per 10 sec.) rested between the two supporting rods, touching the top of the paper. Water (1 c.c.) was added and allowed to flow down until the paper was completely wet; all the sugar is then at the foot of the strip. The dropper was then filled to the top and the flow continued for half an hour (total volume collected, *c.* 5 c.c.). This eluate contained all the sugar from the strip, which could then be estimated by any of the usual methods[1,3,4].

Experiments with D-xylose, D-ribose, D-galactose, D-fructose, L-rhamnose and D-glucose gave theoretical results under these conditions. Estimation of the component sugars in a galactose – fructose mixture was effected by chromatography and subsequent treatment as above. This gave consistent results: galactose, 103 per cent; fructose, 102 per cent (estimation by the periodate method[4]).

Cold-water elution, therefore, affords a relatively rapid method for the complete extraction of filter-paper chromatograms under very mild conditions.

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Interrelationship between Natural Pigments and the Mechanism of Conversion of Carbohydrate into Fat

PARTICIPATION of *Fusarium* pigments in the conversion of carbohydrate into fat was indicated when it was found that the greatest rise in fat production by *Fusarium solani* D_2 purple was paralleled by an increment in pigment formation; the fat content of *Fusarium lycopersici* obtained pigmented on Raulin–Thom medium increased with rising sugar concentration of the medium, while the reverse was true when the mould was grown unpigmented on Czapek-Dox medium; *Fusarium lini* Bolley grew unpigmented in both media and showed no change in fat content[1]. The function of these pigments was clearly indicated by experiments in which solanione was added to the media of growing *Fusaria*. The non-pigment formers produced a fat of greater desaturation under these conditions, whereas the fat formed in the pigmented moulds remained unaffected[2]. Evidence has been presented previously correlating the action of the fatty acid dehydrogenase system of *Fusaria*[3] with that of the pigments so characteristic of this genus. Increased desaturation of the fats of the non-pigmented *Fusarium lini* Bolley was also caused by naphthoquinones chemically related to solanione[4].

The effect of these pigments is interrelated with the action of the fatty acid dehydrogenase system, as can be seen from the fact that the vitamins riboflavin and nicotinic acid, which are known to be integral components of some dehydrogenase systems, produce the ame effects as the pigments[5]. The rise in the nsaturation of the oils formed by the unpigmented *Fusarium lini* Bolley was attributed to augmentation in their content of linoleic acid. These vitamins did not affect the composition of the fat formed by pigmented *Fusarium lycopersici*; but the fat of the unpigmented variants of this mould showed the same change as was the case with the unpigmented *Fusarium lini* Bolley. Here the fat formed in the presence of the pigment lycopersin[6] is less desaturated and contains less linolenic acid than does that obtained from the unpigmented form.

able 1. EFFECTS OF RIBOFLAVIN, NICOTINIC ACID AND SOLANIONE ON FAT FORMATION IN *Fusarium lini* BOLLEY

Sample No.	Added substance (mgm./l.)	Mycelial weight (gm./l.)	Total lipide (%)	Iodine number	Riboflavin content (γ/gm. mycelium)
1	Control	5·50	8·55	111	31
2	0·800 *R*	5·37	6·88	157	32
3	0·500 *NA*	5·30	7·01	153	29
4	1·00 *S*	3·38	7·00	150	34

R, riboflavin; *NA*, nicotinic acid; *S*, solanione

Fusarium vasinfectum resembles *Fusarium lycopersici* in its general appearance. The pigment of the latter was isolated by a method similar to that employed for lycopersin[6]. The two substances displayed similar colour reactions with different alkalis, and their ultra-violet absorption spectra were identical. *Fusarium vasinfectum* usually grows with only slight pigmentation. However, when *i*-inositol is used as the carbon source in a Raulin–Thom medium, a fully pigmented mycelium is obtained when the initial *p*H is acid. On the other hand, a completely colourless mould results from an initially neutral or alkaline nutrient solution. The presence of lactose in the medium gives rise to the least amount of pigmentation when the initial *p*H is acid.

The role of lycopersin in the mechanism of the conversion of carbohydrate into fat can be seen from the results recorded in Table 2. Again, the presence of lycopersin is accompanied by the formation of a fat which is less desaturated than that formed in its absence. This change in unsaturation was found to be due to changes in linolenic acid content.

Table 2. CHANGES IN THE COMPOSITION OF THE FAT OF *Fusarium vasinfectum**

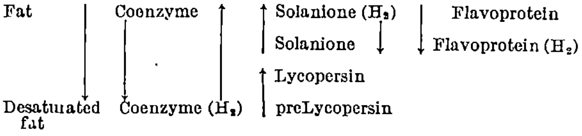
Sample No.	Carbon source	*p*H	Mycelial weight (gm./l.)	Total lipide (%)	Iodine number	Lycopersin content (mgm./gm. mycelium)
1	*i*-Inositol	3·3	6·08	19·8	104	3·48
2	*i*-Inositol	7·0	6·61	20·6	157	0
3	Lactose	3·3	7·45	17·6	133	1·32
4	Lactose	7·0	1·31	21·3	165	0

* The data recorded in this table were obtained by applying the methods used previously (refs. 2, 4, 5).

Further chemical studies on lycopersin indicate the absence of the quinoid nucleus, and the saturation of the pigment with respect to hydrogenation catalysts. This is in distinct contrast to solanione, which is reversibly reducible both *in vitro* and *in vivo*[7].

From these observations the possible mode of action of the fungal pigment may be considered as a participation in the transfer of hydrogen from the donor in part to a precursor of lycopersin. Due to the non-reversible reducibility of the latter, further transfer of hydrogen does not occur, as is the case with solanione. This static behaviour of lycopersin in the action of the fatty acid dehydrogenase system gives rise to a more saturated fat, whereas in its absence a fat of greater desaturation is formed.

The interactions are illustrated by the following scheme:



The above findings prove the interaction of these pigments in the course of action of the fatty acid dehydrogenases of *Fusaria*.

These studies were carried out under the auspices of the Office of Naval Research and were supported by a grant from the F. G. Cottrell Fund of the Research Corporation.

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Fermentation in the Rumen of the Sheep

IN recent years it has become widely accepted that acetic, propionic and butyric acids are important products of the fermentation which takes place in the rumen; but as yet the information most cogent to the nutritional physiology of the ruminant, namely, the quantities of these nutrients which become available to the animal, has not been obtained.

When it was shown by Barcroft and his colleagues[1] that the volatile fatty acids are readily absorbed through the rumen wall, it became evident that an *in vitro* approach would be the one most likely to provide a solution to the problem.

We have set up, *in vitro*, fermentations of wheaten hay and of lucerne hay inoculated with micro-organisms from the rumen, and have found that when the inoculum was sufficiently large, and the conditions similar to those in the rumen, the extent to which the various carbohydrates in these substrates were fermented corresponded closely to the extent of their breakdown in the rumen. Moreover, the amounts of methane formed were of the same order as the amounts formed *in vivo*. Between 30 and 50 per cent of both the cellulose and hemicellulose fractions of the fodders were broken down, and 15–20 litres of methane per kilogram of fodder were produced within forty-eight hours. The quantities of each of the fatty acids formed are shown in Table 1.

Table 1. FATTY ACIDS PRODUCED *in vitro*

Fodder	Acids (gm./kgm. fodder)			
	Acetic	Propionic	Butyric	Total
Wheaten hay	96	101	39	236
Lucerne hay	136	76	48	260

In Table 2 the differences between the composition of the mixture of acids formed *in vitro* and the composition of the mixture in the rumen fluid of animals fed on the same two fodders are shown. If the acids formed *in vitro* are indeed produced in the rumen, then these differences must throw some light on the problem of the relative rates of absorption of the acids through the rumen wall, for a comparison of the ratios of each pair of acids found *in vitro* and *in vivo* will indicate which acid is the more rapidly absorbed. For example, the ratio (acetic acid to propionic acid) in the case of wheaten hay fermented *in vitro* is $46/41 = 1 \cdot 1$, whereas the ratio in the rumen fluid is $71/17 = 4 \cdot 2$, indicating a more rapid absorption of propionic than acetic acid. From all of the data in the table, it may be concluded that when wheaten hay was fermented the relative rates of absorption of the acids fell in the series propionic > butyric > acetic, and in the case of lucerne hay the order was propionic > butyric ≈ acetic.

Table 2. COMPARISON BETWEEN THE ACIDS FORMED *in vitro* AND THOSE PRESENT IN THE RUMEN FLUID

Fodder	Fermentation	Fatty acids*		
		% Acetic	% Propionic	% Butyric
Wheaten hay	*In vitro*	46	41	13
	In the rumen†	71	17	12
Lucerne hay	*In vitro*	59	27	14
	In the rumen†	70	14	16

* Molecular proportions.
† Averages from numerous analyses.

When these fodders are fed to sheep, it is found that the concentration of acid in the rumen rises sharply, and later falls again, reaching its original level within twenty-four hours. If, then, the acids are formed in the proportions which we have found *in vitro*, it is clear that certain changes in the composition of the rumen fluid must take place during the day. For example, the ratio of acetic to propionic acid should decrease immediately after feeding when the rate of production of acid is increasing; and it should increase again later, when production is decreasing or has ceased, because the effect of the different rates of absorption of the individual acids will then predominate. We have examined the composition of the rumen fluid at frequent intervals after feeding both these fodders, and have found that, in general, the predicted changes do take place.

Details of these experiments will be reported elsewhere.

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Isolation of Sodium Hyaluronate

DURING recent investigations for the development of new methods for the isolation and purification of hyaluronic acid from human umbilical cords, the following interesting observation was made. The cords, stored in acetone, were extracted with hot water (65°) and the aqueous extract allowed to 'settle' overnight. The clear supernatant liquid was kept under toluene for fourteen days, when it deposited a precipitate. This was removed, and the clear liquid was acidified with glacial acetic acid. Half the resulting mucin clot was stored in acetone for several weeks. Upon attempting to dissolve it at pH 8·0, it was found to be incompletely soluble, whereas the original clot was soluble. The 'acetone-clot' was extracted with water at pH 8·0, the extract giving only a very faint cloudiness upon acidification to pH 4·0. It was poured into 3 vol. of alcohol and the precipitate re-extracted with water. Finally, a preparation of sodium hyaluronate was obtained nly 4·5 per cent nitrogen (on free acid) and ent ash (3·3 per cent sodium approximately) ; the mucin clot, after reprecipitation, had ent nitrogen and negligible ash content. In aluronic acid, containing only 6–10 per cent , had been extracted at *p*H 8·0 from the clot after acetone treatment.

yaluronic acid (potassium salt) prepared from ein clot by repeated application of the Sevag ure has a high ash content, namely, 20 per pproximately, and 3·2 per cent nitrogen[1]. the Sevag method is useful for removing small ities of protein, it is laborious for larger ities and rather cumbersome when used for a scale preparation. This new procedure is simple asily worked on a large scale. The product may eated, if desired, by the Sevag method to remove ast traces of protein.

therto, most workers, in preparing hyaluronic have aimed at reducing the nitrogen content uch as possible. However, it is feasible that ein may be attached to hyaluronic acid by link- other than the usually assumed salt type, and h may be ruptured by prolonged Sevag-treat- t at the usual *p*H 8·0. Consequently, it is possible the present method of preparation might yield ducts of interest from this point of view.

etails of this and further work will be published a later date.

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Use of Hyaluronidase in Microtechnique

The highly viscous cement or matrix of connective ssue consists of proteins and mucopolysaccharides, e latter containing hyaluronic acid (or acids)[1]. The iscosity of the matrix can be reduced by hyaluron- dase (the spreading factor)[2] almost to that of water y depolymerization and hydrolysis of hyaluronic acid. McClean[3] showed that testicular extract containing the spreading factor allowed a more extensive spread of indian ink when injected into the dermis than did Ringer's solution. The extract produced a "swelling and splitting" of collagen fibres due to increased permeability of the fibre bundles rather han to any change in the collagen itself. Robb-Smith[4] lso found that testicular hyaluronidase brought about paration of the reticulin network from muscle res, but had no histologically demonstrable effect other parts of the fibre or its nuclei.

We have, therefore, used commercially available aluronidase to facilitate the diffusion of impreg- ting substances in skin. Post-mortem human skin s treated for one hour at 37° C. with a solution taining 10 μgm. of active freeze-dried testicular ract per ml. For complete penetration the strips material should not exceed 2 mm. in thickness, d be freed of subcutaneous tissue. Carey's[5] modi- ation of Ranvier's gold chloride technique was then plied, the epidermis removed by gentle shaking d the material dissected in glycerine using glass truments. In this way it has been possible to monstrate, without resorting to sectioning, the ve plexus in the dermis, and the enervation and scular supply of the dermal papillæ, among which variety of encapsulated sense organs are to be found.

We have also used solutions of hyaluronidase in Ringer's solution to separate cells in the liver and in the snail's foot.

The method presents great advantages over the classical macerating agents, since it is rapid in action, causes a minimum of disturbance to cytoarchitecture and does not, so far as we can tell from oxygen uptake measurements on liver, result in the death of the cell.

Hyaluronidase is active over a wide range of *p*H and has an optimum round about *p*H 5·0 in solutions of buffer salts[2]. It is inactivated by temperatures above 60° C., and its activity falls rapidly at temperatures above 40° C. Dilute solutions can be stored for about a week at 4° C., provided they are not contaminated. Inhibitors to be avoided or carefully washed out of tissues before treatment with hyaluronidase are formaldehyde, iodine, sodium nitrite, ammonium sulphate, sodium sulphate and sterols[6]. Preparations mounted from water are very susceptible to infection, so that a suitable fungicide (cresol, phenylmercurinitrate, etc.) must be added to mount media.

Our thanks are due to Bengers, Ltd., who provided the sterile freeze-dried preparation of testicular hyaluronidase used in this work.

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Enzymic Formation of a New Riboflavin Derivative

Homogenates of rats' livers, and aqueous extracts of acetone powders of rats' livers, have been found to convert riboflavin into a flavin chromatographically different from riboflavin, flavin mononucleotide, and flavin adenine dinucleotide. The amount formed increases with time, and the conversion is accelerated by rise in temperature, but does not occur after heating at 100° C. The reaction is therefore thought to be enzymic. The flavin cannot be detected in unincubated homogenates which have been concentrated many times by Crammer's[1] method for extracting flavins.

Table of *Rf* Values

Solvent :	1	2	3	4	5
Riboflavin	0·30	0·46	0·18	0·47	0·25
Flavin mononucleotide	0·09	0·17	0·00	0·06	0·5
Flavin adenine dinucleotide	0·03	0·05	0·00	0·02	0·35
New flavin	0·20	0·36	0·09	0·23	0·4
Lumiflavin	0·40		0·28		
Lumichrome	0·70				

Solvent 1. 4/1/5 *n*-butanol/acetic acid/water.
,, 2. 5/3/2 *n*-propanol/pyridine/water.
,, 3. 2/2/1 *n*-butanol/*n*-propanol/water.
,, 4. 3/1/1 benzyl alcohol/ethanol/water.
,, 5. 5 per cent aqueous solution of Na_2HPO_4, $12H_2O$ (ascending chromatogram).

This flavin is not a photodecomposition product of riboflavin. Lumiflavin can be prepared from it, using Warburg's[2] conditions for preparing lumiflavin from riboflavin ; this indicates that the modification has occurred in the ribityl side-chain, not in the *iso*alloxazine part of the molecule. It has a partition coefficient of 0·54 between benzyl alcohol and water (compared with 3·2 for riboflavin, 0·010 for flavin mononucleotide and 0·004 for flavin adenine dinucleotide[3]), of which fact use is made during the isolation of the material. Comparison of the absorption spectra of riboflavin and of the flavin under investigation reveals no significant differences.

Recently a new flavin, flavin-X, has been reported in the literature[4], but the possibility that the flavin here described may be identical with flavin-X is eliminated by the fact that it does not contain phosphorus, whereas flavin-X is reported to be a flavin dinucleotide.

The possibility that this new flavin may be lyxoflavin[5] has not yet been excluded; it is, however, considered unlikely that so small a change in structure can account for so many differences in properties. Investigations are continuing on the nature of the compound, and they will be published in full elsewhere.

I am indebted to Dr. M. Dixon for his advice and encouragement, and to the Medical Research Council for a grant.

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Anticoagulant Activity of the Indian Cattle Leech

THE anticoagulant activity of leeches has been known for a long time. Haycraft[1] obtained a saline extract of the anticoagulin from the head of a leech, and found that a dose of 0·01 mgm. would prevent the normal coagulation of 50 ml. blood for four and a half hours. Various investigators have since employed different techniques in their study of the anticoagulant action of leech extract. In our experiments with the common Indian cattle leech (*Hirudinaria*), an extract of the anticoagulant substance was prepared from the first eight segments of the body of the leech. The tissues were pounded with pure quartz sand in a mortar and the solution filtered through a cotton plug, freed from protein and buffered to *p*H 7·2 with Sørensen phosphate buffer.

Preliminary observations on the effect of freshly prepared extract were made on human and other mammalian blood *in vitro* and on white mice (weighing 60–100 gm.) *in vivo*. The coagulation time recorded in each experiment was much prolonged, and no case of hæmolysis of blood, as noticed by some previous investigators, was met. The extracted solution in most cases seemed to retain its anticoagulant property up to three weeks when stored at room temperature, with a maximum range between 95° and 100° F.

Furthermore, it was found that the fresh extract was absolutely non-toxic (unlike the one found by Marshall[2]) when administered to white mice by the intravenous, intramuscular or oral route.

There was a considerable increase in blood coagulation-time in white mice when freshly prepared extracts were administered by an intravenous or an oral route. The results of intramuscular injection in
white mice were variable and require further el
tion.

The two important anticoagulants whic
been used therapeutically are heparin and dic
Whereas heparin is only effective when g
travenously, dicumarol is useful only whe
orally. The extract from the Indian leech ap
act as an effective anticoagulant both by
travenous and oral routes.

Further work is in progress to evaluate t
parative yield and the therapeutic antico
effect of the extract from *Hirudinaria*.

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Dielectric Properties of the Human Bc for Wave-lengths in the 1–10 cm. Ran

A SUMMARY of the results of measurements o
dielectric properties of a representative selectic
body tissues at a wave-length of 3·18 cm. has alr
been published[1]. These measurements have now
extended to two other wave-lengths, namely,
cm. and 10·0 cm., the method used being simila
that already described. All specimens, with
exception of bone, were taken from surgical op
tions, and measurements were made in each case
the minimum of delay and at a controlled tempera
of 37·0 ± 0·5° C.

In Table 1, the results for these wave-lengths
tabulated, each being expressed in terms of
absorption constant (α) and a phase constant (β)
the tissue filling the aperture of a wave-guide ap
priate to the wave-length used. The figures given
the average values obtained from two or m
measurements on sections from one source, and
averages for sections from different sources are
cluded, where possible, to indicate the variati
encountered in practice. The measurement accura
are estimated as ± 10 per cent in α and ± 5 per c
in β for 1·27-cm. wave-length and ± 5 per cent
α and ± 2 per cent in β for 10·0-cm. wave-leng

In Table 2, the real and imaginary components
the complex dielectric constant $\bar{\varepsilon} = \varepsilon' - j\varepsilon''$, c
culated from the measured constants for a numl
of tissues, are compared at the three wave-lengt
10, 3·18 and 1·27 cm.

As with the 3·18 cm. wave-length, the measur
constants for the two wave-lengths 1·27 and 10·0 c
may be compared with those for water, the latt
being present in a high percentage in all the tissu
other than fat and bone. Determined in the san
equipment, the constants for water at 37° C. we
$\alpha = 12{\cdot}3$, $\beta = 34{\cdot}2$ for 1·27-cm. wave-length, a
$\alpha = 0{\cdot}3$, $\beta = 5{\cdot}4$ for 10-cm. wave-length.

The general conclusions to be drawn from t
measurements at the two wave-lengths are the sar
as those for 3·18-cm. wave-length, namely, that ma
of the body tissues behave very similarly to water
respect of their dielectric properties, that fat a
bone, having much lower water contents, are re
tively transparent to the radiation and that maligna
and normal tissues do not differ significantly. Or
difference between tissue behaviour relative to wate

Table 1

pecimen	λ = 1·27 cm. α (nepers/cm.)	λ = 1·27 cm. β (radians/cm.)	λ = 10·0 cm. α (nepers/cm.)	λ = 10·0 cm. β (radians/cm.)	Remarks
lood	9·5	31·0	0·65	4·6	Uncoagulated by 1/500 mgm. heparin
	9·7	28·9			
rum	10·3	34·7	0·84	5·3	Centrifuged specimen
	6·4	23·2	0·81	4·1	
	6·3	25·4	0·65	4·5	Breast specimens free of areolar tissue
			0·73	4·6	
	1·95	9·2	0·21	1·45	
	1·0	8·6	0·20	1·70	Breast specimens free of areolar tissue
	1·5	8·7			
	0·9	11·9			
	0·95	11·7	—	—	Post-mortem specimens. Sections taken at different depths from the surface
	1·2	12·9			
	1·45	12·5			
noma of breast	8·1	28·6	0·73	4·8	All specimens confirmed scirrus carcinoma by histological examination
	6·9	25·2	0·60	5·0	

Table 2

ecimen	ε′ (relative to air) 10·0 cm.	ε′ (relative to air) 3·18 cm.	ε′ (relative to air) 1·27 cm.	ε″ (relative to air) 10·0 cm.	ε″ (relative to air) 3·18 cm.	ε″ (relative to air) 1·27 cm.
le blood	53	45	32	15	23	20
serum	70	57·5	45·5	22·5	24	29
	43·5	35·5	23	16·5	16	13
	6·9	4·5	3·4	1·6	0·95	1·1
	—	7·6	6·3	—	1·45	1·1

0-cm. wave-length and at the shorter wave- ths is that the absorption constant α tends to e a value approximately double that of water, icating the significant contribution of the ionic nductivity absorption. Assuming equal contribu- ions to total absorption at this wave-length by the olar water molecules and by ionic conductivity, a alue of the order of 10^{-2} mhos per cm.[3] is obtained or the typical tissue conductivity, which is in agree- nent with the values obtained from measurements t longer wave-lengths (summarized by Osborne and olmquest[2]). The ionic conductivity contributions power absorption in such tissues at wave-lengths 3·18 cm. and 1·27 cm. would appear, by similar lculation, to be about 10 per cent and 2 per cent spectively, and would not be immediately evident n the measured constants.

The assistance of Dr. N. A. Sharples in selection and preparation of specimens is gratefully acknow- ledged.

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Reaction for the Study of the Kinetics of Electron Transfer

HE isolation[1] of stable optical forms of the tris 2′ dipyridyl osmium II ion, $Os(dipy)_3^{++}$, and of tris 2 : 2′ dipyridyl osmium III ion[2], $Os(dipy)_3^{+++}$, mits a unique demonstration of the dynamic tronic equilibrium between the oxidized and uced forms of an ion. It is evident that when the ro form of the osmium II complex ion is mixed an equivalent amount of the *lævo* form of the ium III complex ion, the optical activity of both should vanish if such an equilibrium exists.

$$\text{D } Os(dipy)_3^{++} \rightleftharpoons \text{D } Os(dipy)_3^{+++} + e'$$

$$\text{L } Os(dipy)_3^{+++} \rightleftharpoons \text{L } Os(dipy)_3^{++} - e'.$$

The experiment was carried out by mixing 10 mgm. of D,tris 2 : 2′ dipyridyl osmium II perchlorate with 10·9 mgm. of L,tris 2 : 2′ dipyridyl osmium III perchlorate in 20 ml. of water at 20° C. After two minutes, the osmium II complex was precipitated by the addition of 20 per cent sodium perchlorate solution, leaving a pink solution of the osmium III complex. Both the precipitate and the filtrate were found to be inactive.

Essentially the same experiment has been carried out in the studies of the ferrous/ferric and the tris ethylene diamine cobalt II/tris ethylene diamine cobalt III equilibria with radioactive iron[3] and cobalt[4]. However, the present experiment may also be used to determine the rate of electron transfer under varying conditions of temperature, concentration, and dielectric constant of the solvent without the necessity of altering the conditions by separation of the oxidant and the reductant.

Tris 2 : 2′ dipyridyl osmium II perchlorate has $[\alpha]_{5461}^{25} = 2200°$, while for tris 2 : 2′ dipyridyl osmium III perchlorate, $[\alpha]_{5461}^{25} = 200°$. The mixture of equivalent amounts of the D osmium II complex and L osmium III complex, at the instant of mixing, is therefore dextrorotatory, and the loss of activity consequent on electron transfer can be followed in a polarimeter. The intense green colour of the reduced form of the complex necessitated the use of very dilute solutions, and the maximum angle of rotation that could be comfortably observed was about 0·08°.

With the mixed solution 5×10^{-4} M with respect to both ions, the exchange was complete in less than 15 sec. at 25° C., but required approximately 65 sec. at 10° C. and 95 sec. at 5° C. The rate at 10° C. was very much greater in 2 N ammonium nitrate solution, but much slower in acetone, than in water. Both these effects are obviously related to the dielectric constant of the solution.

It is hoped to study quantitatively the effects of various factors, particularly concentration, with a photo-electric polarimeter.

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Lattice Constant of Grey Tin

THE crystal structure of α-tin (grey tin) is given by Bijl and Kolkineiger[1] as a diamond-type structure, having $a = 6\cdot46$ A., and the X-ray density as $5\cdot81$ gm.cm.$^{-3}$.

We have been supplied with a sample of grey tin prepared by Mr. J. T. Kendall of the City and Guilds College, London, and have measured its lattice spacing at room temperature. Nickel-filtered copper radiation was used. Assuming λ for copper $K\alpha_1 = 1\cdot54050$ A.[2], the lattice spacing in absolute angstrom units is $6\cdot4912 \pm 0\cdot0005$ A. The X-ray density, calculated from the formula[2] $\rho = 1\cdot66020\Sigma A/V$, is $\rho = 5\cdot765$ gm.cm.$^{-3}$.

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Graticules as Guides in Electron-Microscope Metallography

ONE of the greatest difficulties for the user of an electron microscope in metallography is the localization of a micrograph on the original specimen. The high magnification gives a very small area of observation which is, in general, less than $15\,\mu \times 20\,\mu$. It is, for example, only one three-thousandth of the area of a 1-mm.^{2} specimen, and it is therefore practically impossible to identify it again.

A method of solving the problem has been developed in this Laboratory. It consists in cutting a fine graticule on the polished metal surface. An ordinary diamond as used in optical microscopy is not suitable, however, because the finest lines which it can give are too coarse. This causes the replica film to break along the lines and, moreover, the lines themselves are too broad, so removing too great a part of the specimen.

We have developed an instrument, manufactured by LKB-Produkter, Ltd., at Stockholm, which enables us to scribe a metal surface with lines of width less than $2\,\mu$. The instrument stands on a microscope base. A diamond, suspended from an arm, can move over the specimen surface and is lifted from it on the return stroke. The cutting pressure, which is of the order of $0\cdot01$ newton, can be adjusted by means of a sliding weight. The limit of measurements is about $0\cdot2\,\mu$.

The replica is prepared in two stages with collodion and aluminium. To strengthen the aluminium film, we have used double evaporation, both at an angle of 10° to the normal of the surface, giving an angle between the two evaporation directions of 20°. The collodion is dissolved in amyl acetate and the freely floating aluminium specimen is picked up on the slide.

Localization is made easier if every line in the graticule is capable of individual identification. For these experiments we have chosen a master spacing of $50\,\mu$, while the maximum number of lines in any one group is four. We have chosen different minor spacings in the horizontal and vertical direction, namely, $4\,\mu$ and $6\,\mu$ respectively.

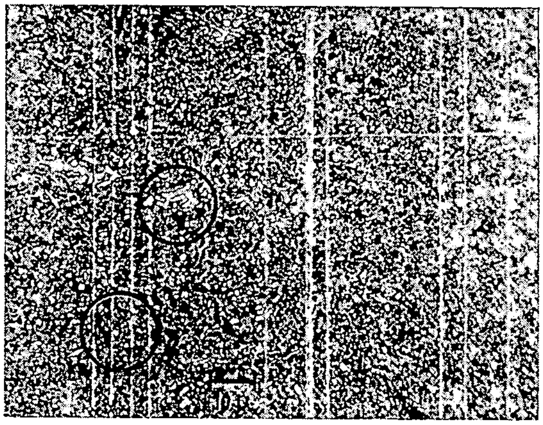

Fig. 1. Steel Sandviken 22Cl, 1·1 : 1·2 % C, 0·5 % Cr; heat-treated for one hour at 780° C. (optical microscope, × 450)

No difficulty has been experienced due to the scribed lines being obscured by 'bars', since the geometrical regularity of the pattern renders the lines easily identified.

We have demonstrated the use of the instrument for the study of steel (Sandviken 22Cl, 1·1 : 1·2 per cent carbon, 0·5 per cent chromium). The steel had been heat-treated for an hour at 780° C.

Fig. 1 shows part of the specimen with 450 magnification. One of the marked parts is shown in Fig. 2 with 4,500 magnification. The light spots are carbides, whereas the background is martensite.

A comparison of the electron micrographs and optical micrographs shows good similarity in all

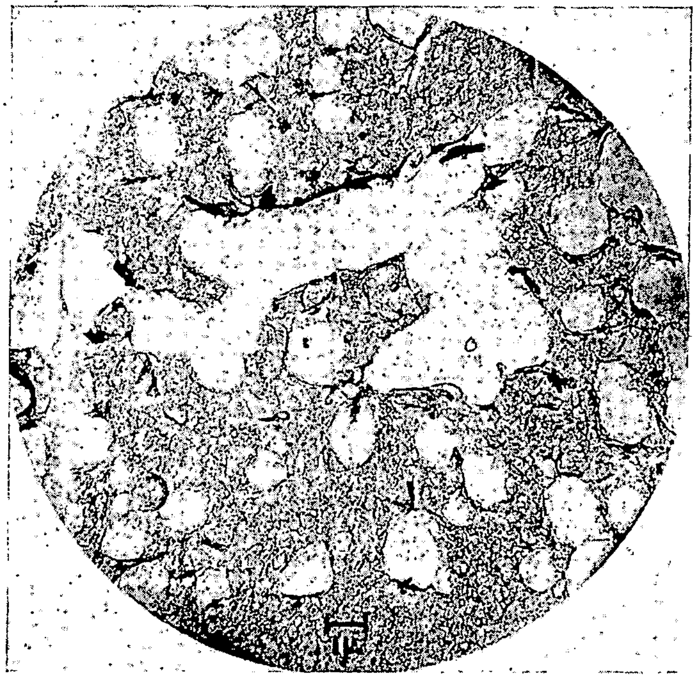

Fig. 2. Part of Fig. 1 (electron microscope, × 4,500)

letails, proving that the electron microscope can give reliable pictures.

With further development the instrument might be used as a microhardness tester. The breadth of the ines passing through different parts of the specimen can give an idea of the relative hardness of the grains.

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Viscosity of Metallic Liquids

The viscosity of metallic liquids has been comparatively little studied, mainly due to the experimental difficulties characteristic of viscosity measurements at higher temperatures. The interest in viscosity data is, however, considerable. On the theoretical side, such data would provide further information towards the understanding of the liquid state, while, in the field of applied metallurgy, the viscous nature of liquids is tied closely with the flow behaviour of metals in filling moulds. The paucity of data in these fields can be appreciated from the fact that even such important problems as the variation of viscosity as a function of temperature close to the melting point of a metal, and the variation of viscosity as a function of composition in binary alloy systems, have not been fully studied experimentally.

Viscosity measurements which have been recently carried out in this Department show that certain views normally held on these points are not supported by experiments. For example, it is generally assumed[1] that the relationship of viscosity to temperature is given by:

$$\eta = A \exp B/RT,$$

and that this expression holds true to the melting point of the metal. The experimental results we have obtained with tin, lead and certain binary alloys, however, show the relationship indicated in Fig. 1. It is clear that the absolute viscosity changes rather markedly a few degrees above the melting point.

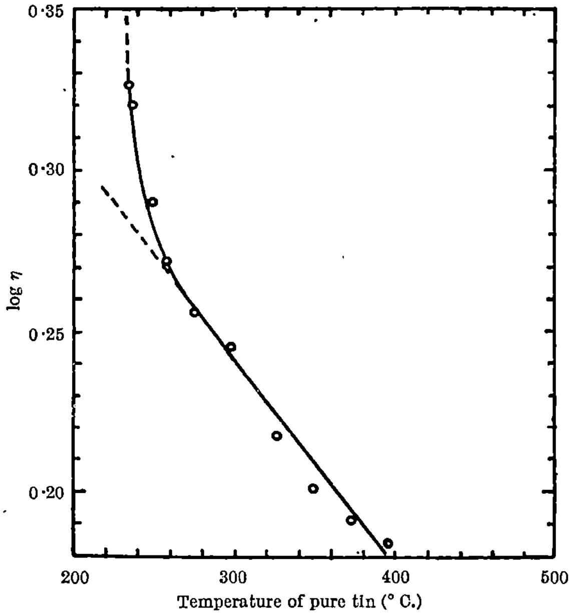

Fig. 1

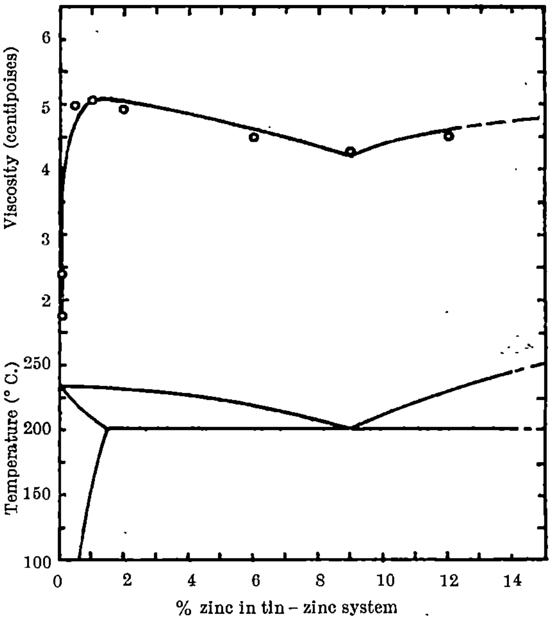

Fig. 2

On the question of the relation of viscosity to the composition of simple binary alloy systems, it is generally taken that viscosity is an additive property of the mixture of the two metals[2], and that deviations from this rule are only obtained in the presence of strong intermetallic compounds in the system. Our experimental results, which were carried out over a considerable range of temperature and composition, show, on the other hand, that the viscosity of simple systems, for example, tin–zinc, is represented by the relationship indicated in Fig. 2. It is interesting that such correlation of viscosity with constitution is only obtained when viscosity is plotted at a constant temperature above the liquidus for the system, rather than at a constant absolute temperature. A similar relationship was observed by Poliak[3] with aluminium–silicon alloys.

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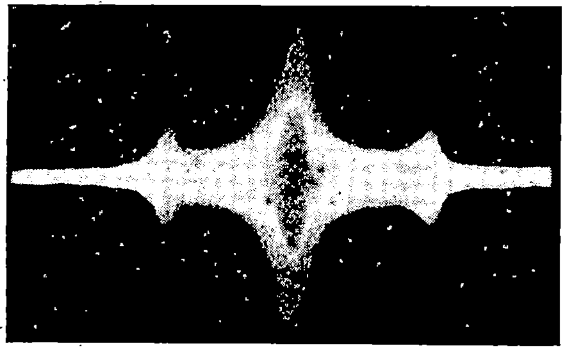
A Resonant Circuit with a Time-Variant Resistive Element

Much attention has been devoted to a study of the effects associated with periodic variation of inductive and capacitive elements (the energy-storage elements) of resonant circuits. The present communication is concerned with two closely related phenomena arising from periodic variation of the resistive element of a series or parallel circuit.



The first phenomenon is that of multiple resonance[1,2] and is illustrated in the accompanying oscillogram for a circuit tuned to 6 kc./s., the resistive element of which was being varied at 50 c./s. by means of a negative resistance. The abscissa represents the frequency of a driving E.M.F. and the ordinate the associated voltage (which varies in amplitude at 50 c./s.) across the main circuit capacitance; the average circuit resistance remained positive throughout the 50 c./s. variation. It can be shown that peak responses occur at frequencies $f_0 \pm nf_1$, where $f_0 = 1/2\pi\sqrt{LC} = 6 \times 10^3$ c./s., $f_1 = 50$ c./s. and $n = 1, 2, 3. . .$ The photograph shows only three such peaks, one below and one above f_0, but as many as six below and six above have been observed. The selectivity in the region of the central response increases with the amplitude of the resistance variation.

The second phenomenon is that of parametrically excited oscillations[3,4] resulting when the effective circuit resistance varies at a frequency $f_R \approx 2f_0$, and at the same time the resistance is allowed to become negative during part of its cyclic variation. Oscillations of substantially constant amplitude and purity of wave-form exactly half the frequency of the resistance variation $f_R/2$ occur over a range of frequencies near f_0. The range is limited by sharp cut-off of the self-oscillation, and this suggests the use of the device as a filter, particularly since the band-width is readily controlled.

The theoretical basis of these phenomena lies in Hill's equation[5]:

$$\ddot{y} + [a - 2q\,\psi\,(2z)]y = F(z),$$

where a and q are constants, and $\psi(2z)$ and $F(z)$ are periodic functions of time. Good quantitative agreement has been obtained between experiment and, on one hand, multiple resonance calculations from the particular integral solution, and on the other, calculation of the self-oscillation frequency and band-width obtained from the solution in the unstable $a - q$ region of the complementary function. Full particulars will be given in a later publication.

We are indebted to E. H. Ballantyne and L. S. Dektereff for assistance with the experimental work.

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An Improved Type of Wetted-Wall Column

Preliminary investigations, carried out in this Department, have shown that the efficiency of a wetted-wall column may be improved by subjecting the liquid and vapour phases to a rapidly oscillating pressure. This induces increased turbulence in the refluxing liquid, resulting in a larger surface area for mass transfer.

A wetted-wall column was attached, via the condenser, to a cylinder closed by a reciprocating piston. Pressure changes of the order of 15 per cent at a frequency of 20 cycles per second have resulted in an increased efficiency of approximately 50 per cent, expressed in terms of theoretical plates.

The efficiency of a column 'packed' with a gauze spiral may also be increased by this device, but to a lesser extent, dependent upon the packing density.

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May 17.

Occurrence of a Network in the Excrement from the Larva of the Clothes Moth

As a detail in an investigation of the degradation products from enzymatic digestion of wool, excrement from the larva of the clothes moth (*Tineola bisselliella* Hummel) have been subjected to examination in the electron microscope.

The pellets were ground in an agate mortar and suspended in water. A droplet of the suspension was placed on the collodion film, dried and shadow-cast with gold-manganin. The examination was carried out with an *RCA* microscope, type *EMU*.

Among various stages of disintegrated wool particles very regular networks were also observed, often covering areas with diameters up to more than 50 μ. Three different main types could be recognized. The first one (Fig. 1) is the regular 'fishing-net' pattern, constituted by threads or fibres running in three main directions, thus forming symmetrical meshes with a width of about 0·2 μ. These fibres are themselves bundles of fibrils, each of which has a thickness of 50–60 A. At the junctions it can be seen how the fibrils from different threads are plaited. The fibrils can also be observed in the places where the fibres are split up, for example, near the borders of the network. The regularity of the pattern is well preserved even near the border. The second type is shown in Fig. 2. Basically, it consists of the same network, which can be recognized on the photograph; but here the meshes are filled up with some substance so that a continuous background membrane is formed. The white formations are bigger, extraneous particles lying underneath the membrane. In the third type, shown in Fig. 3, the fibrils seem to be arbitrarily arranged and the regular pattern has been destroyed, at least partly. Parts of the network, forming stages between the first and third types, have also been observed.

It may be worth mentioning that these networks were very scarce if the specimen was prepared immediately after suspending the ground pellets in water. If, however, the same suspension was allowed to stand for about two days at room temperature, the networks were both bigger and more abundant. It seems probable that the network originates from the intestines of the moth larvæ, as we have also

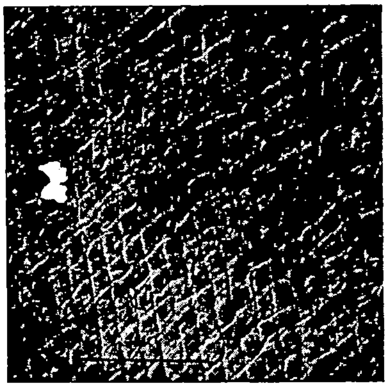

Fig. 1

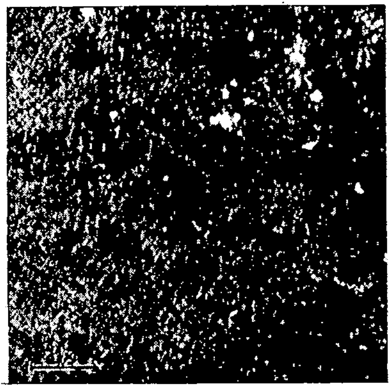

Fig. 2

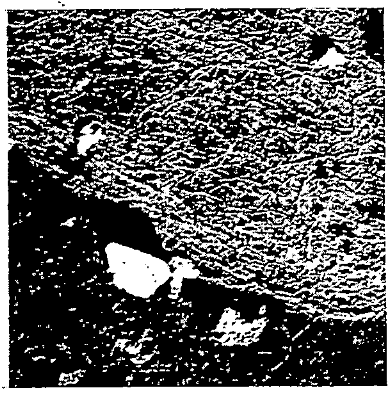

Fig. 3

Fig. 1. Regular network from the excrement of the larva of clothes moth. Shadowed with gold-manganin

Fig. 2. Continuous membrane in which the regular 'fishing-net' pattern can be recognized. Shadowed with gold-manganin

Fig. 3. Arbitrarily arranged fibrils. Shadowed with gold-manganin

found them in the excrement from larvæ fed on a diet free from wool. These networks seem to be similar to the structures in *Dixippus morosus* recently reported by Huber and Haasser[1].

Gösta Lagermalm
Bo Philip
Nils Gralén
Swedish Institute for Textile Research,
Gothenburg.
April 28.

[1] Huber, W., and Haasser, C., *Nature*, **165**, 397 (1950).

A Localized Effect of Light on the Protoplasmic Viscosity of Plant Cells

If one half of a leaf of *Elodea densa* is illuminated, the other half being screened off, a decrease in the permeability strictly localized to the illuminated area is observed[1]. This area accumulates methylene blue considerably more strongly than the unilluminated area.

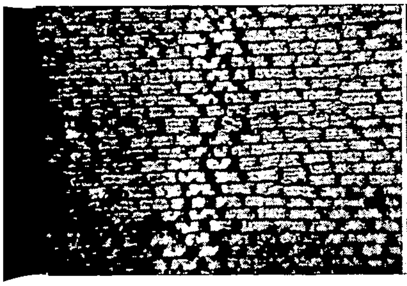

Fig. 1

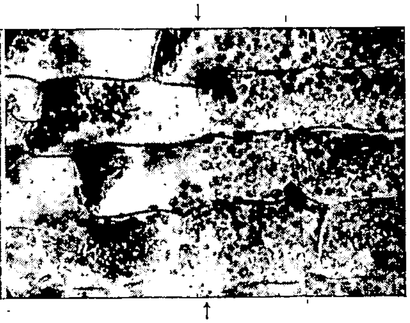

Fig. 2

g. 1. A leaf of *Elodea densa* which has been illuminated through a small aperture in a piece of tinfoil and then centrifuged

g. 2. Some centrifuged cells of *Helodea densa* of which part has been illuminated. The illuminated area is seen to the left of the arrows

Illumination of cells with strong visible light (for xample, 22,000 m.c. incandescent light) also causes n appreciable decrease in the viscosity of the plasma. his is demonstrable by the fact that the cell contents, ch as the plasma with its component plastids, of lls which have been illuminated can be made to ove considerably more easily under the influence of ntrifugal force than those of unilluminated cells[2-5].

It has now been found that this decrease in the viscosity is strictly confined to that part of the leaf that has been illuminated. Thus, if a leaf of *Elodea* is covered with a strip of tinfoil in which a small aperture with even edges is cut, and the leaf is centrifuged after illumination, only that part of the leaf under the aperture in the tinfoil has been affected (Fig. 1). Closer examination of the cells adjacent to the edges of the aperture reveals occasional cells only part of which has been illuminated. It is found that the viscosity is decreased only in illuminated parts of the cells, the unilluminated parts being unaffected (Fig. 2). This is thus an example of a reaction in which the site of the perception of stimulus and of the reaction is the same.

It has been shown earlier[2-4] that changes in the viscosity of the plasma due to light constitute a reaction which is in all probability a general phenomenon. The above observations with respect to the localized effect of the light energy applied—which is evidently intimately connected with the changes in permeability—suggest an explanation of the phototropic phenomena in polar organs such as the coleoptile of *Avena*, which has a polar stream of hormones. Unilateral illumination of such an organ causes changes in the viscosity and the permeability respectively of the plasma in the cells treated. This may possibly be the reason for the unequal distribution of the stream of hormones originating in the tip of the organ.

Further details of these experiments with respect to the viscosity changes in illuminated plant cells will be published later.

Hemming I. Virgin
Institute of Physiological Botany,
University of Stockholm.
May 2.

[1] Lepeschkin, W. W., *Amer. J. Bot.*, **17**, 953 (1930).
[2] Stålfelt, M. G., *Arkiv Botan.*, A **33**, No. 4 (1946).
[3] Virgin, H. I., *Physiol. Plant.*, **1**, 147 (1948).
[4] Virgin, H. I., *Exp. Cell Res.*, Supp. 1, 79 (1949).
[5] Voerkel, H., *Planta*, **21**, 156 (1934).

Malaria Eradication in Ceylon

One of the most important vectors of malaria in India, and the only vector so far reported in Ceylon, is *A. culicifacies.* Afridi and Puri[1] reviewed the available literature relating to this species in India. Covell[2] lists the countries where this mosquito has been found, its breeding places, adult habits and relation to malaria. In India, this is reported to be a domestic species. James and Gunasekera[3] were the first to find this species infected in Nature in Ceylon. Carter and Jacocks[4] confirmed these findings. During the various regional epidemics that occurred in Ceylon during and since 1934, this was the only anopheline species found infected with malarial parasites. According to Carter (unpublished reports), *A. culicifacies* in Ceylon is domestic in its habits and has been captured in dwellings and in human-baited traps. It breeds profusely in the sand pools and rock pools in the beds of streams and rivers. The breeding places so far described were in the close vicinity of human habitations.

A scheme of country-wide residual spraying of DDT was inaugurated in Ceylon in 1945, and during the past four years a remarkable reduction in malaria endemicity has been brought about. Encouraged by these results, the question of total eradication of the vector species on the lines of work undertaken in Brazil, Egypt, Cyprus and Sardinia was seriously contemplated. But considerable doubts about the feasibility of undertaking total eradication were entertained for various reasons, one of which was the possibility of *A. culicifacies* breeding in jungle areas away from all human habitation.

In a preliminary survey carried out in 1948 in connexion with the Gal Oya irrigation project in the dry zone (annual rainfall of 50–75 in. with practically no rains during eight months of the year), a jungle area on the eastern side of Ceylon, L. F. Gunaratne (unpublished report) had found the larvæ of *A. culicifacies* in sand pools in the bed of the Gal Oya at a distance of more than a mile from the nearest human habitation. Before total eradication was undertaken, it was considered necessary to carry out further investigations into the breeding of this species in the jungle areas.

Two areas, one in the north-west and the other in the south-east parts of Ceylon, were selected, and an intensive search was made both for adults and for larvæ in the available water collections. In the north-western area, the search was confined chiefly to the sand and rock pools in the beds of two perennial rivers, all other ground-water having practically dried up at the time the search was made. In the south-eastern area, besides two rivers, there were small collections of ground-water such as pools, channels, swamps and tanks, which were searched. Thatched huts, 15 ft. × 15 ft. × 8 ft., were erected in both areas close to the banks of these rivers, and captures of adults were made continuously throughout the night, using human bait.

In the north-western area, 6,250 yards of the margins of the two rivers yielded 2,572 anopheline larvæ, of which 295 (11·4 per cent) were *A. culicifacies.* In numerous disconnected sand and rock pools with a total area of 1,210 sq. yd. were found 9,968 anopheline larvæ, of which 3,831 (37·9 per cent) were *A. culicifacies.* The nearest human habitation was at a distance of two to five miles from these rivers, which flow through dense jungle in which there was scrub as well as high forest forming an impenetrable belt. A total of 247 anopheline adults, of which 123 (50·6 per cent) were *A. culicifacies,* were caught in 100 catching hours, some while in the act of feeding on human baits and others while resting on the thatch after the feed.

In the south-eastern area, 2,445 yards of river margins yielded 1,960 anopheline larvæ, of which only six (0·3 per cent) were *A. culicifacies.* Seventy sand and rock pools with a total surface area of 120 sq. yd. had 1,994 anopheline larvæ, of which 236 (11·9 per cent) were *A. culicifacies.* The nearest human habitations were at distances of four to seven miles from the sections of the rivers which were examined. Of the other collections of ground-water examined in this area, the only one which had a single larva of *A. culicifacies* was an earth channel taking off from a tank. Two catching stations, one at a distance of four miles from the nearest human habitations and the other at six miles, yielded 85 *A. culicifacies,* which is 87·6 per cent of a total of 97 adult anophelines caught in 40 catching hours.

There was no question of larval drift from upstream, for the pools which are the main breeding places were disconnected isolated pools. The adult-catching stations were put up in the midst of thick jungle into which adult *A. culicifacies* could not have been transported passively by vehicles, since no vehicles could be taken to these areas. Nor could they have infiltrated such long distances from the nearest villages through the thick belt of scrub and high forest. Further, a good many were freshly emerged adults with their wing markings intact. There is no reason to doubt that this species is breeding in the jungle at long distances away from human habitation. This finding is contrary to the views held hitherto that in Ceylon *A. culicifacies* is a domestic species living in close proximity to human habitation. In these circumstances, it is obvious that eradication of this species in Ceylon is not a practical proposition.

A detailed study of *A. culicifacies* in Ceylon will be reported elsewhere.

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Ceylon.

May 16.

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[1] Afridi, M. K., and Puri, I. M., *J. Malaria Inst. India,* **3,** No. 1, (1940).

[2] Covell, G., *J. Malaria Inst. India,* **5,** No. 4, 401 (1944).

[3] James, S. P., and Gunasekera, S. T., Sessional Paper 34 (1913).

[4] Carter, H. F., and Jacocks, W. P., *Ceylon J. Sci.,* D, **2,** Pt. 2, 67 (1929)

An Improved Method for Mounting Mosquito Larvæ

The successful preparation of permanent mounts of mosquito larvæ has for long been an arduous and uncertain operation; mounts in balsam are time-consuming and frequently unsatisfactory, while mounts in chloral gum media do not keep well in some climates. The most recent advance is the medium of Bhatia[1], consisting of pine rosin in eucalyptus oil, which is simple to use and gives a fair result. However, comparative tests of this medium against another which I have recently developed indicate that the latter gives an even more satisfactory result.

This new medium consists of a solution of Canada balsam in phenol (Phenol Liq. B.P.), prepared by heating the Canada balsam to drive off any water present, and adding phenol to the cooling mass until a satisfactory consistency is obtained. Larvæ are mounted direct from 95–100 per cent alcohol, the ventral surface of thorax and abdomen being first pierced in several places with a fine needle. Mounts clear rapidly and are sufficiently firm for use after several days in the sun.

A further refinement of the method, for use when perfectly cleared specimens are required for systematic research, etc., is to macerate specimens first in strong chloral hydrate solution (80 gm. in 20 c.c.) or 30 per cent acetic acid. Larvæ should be killed in hot water or other fixative and pierced with fine needles as above, and then placed in the chloral hydrate for twenty-four hours or more. They should then be washed in 90 per cent alcohol and given a short phenol bath prior to mounting in the phenol-balsam. As such specimens are very soft, the transfer to the slide should be made by pipette. Such mounts are perfectly transparent, being little more than larval skins, and are most useful where ventral hairs are to be examined. The method is, however, only applicable to fresh material; old specimens from alcohol fail to clear in chloral hydrate.

Bhatia's pine rosin has also been tested in phenol solution and gives a result equally as good as the balsam medium—sometimes a little better. But as the keeping qualities of the rosin have not yet been tested over a long period, I prefer to use balsam.

The above processes are presumably applicable to other small Arthropoda. A more detailed account is being prepared for publication elsewhere.

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Labuan,
British North Borneo.
May 10.

Bhatia, M. L., *Ind. J. Malar.*, **2**, No. 4, 283 (1948): *Nature*, **164**, 64 (1949).

Deposition of Air-borne Particles on Trap Surfaces

Sticky traps in the form of vertical cylinders, and vertical or horizontal plates, are widely used to estimate the numbers of air-borne particles such as pollen, fungus spores, fungicides and insecticides. Although a knowledge of factors controlling deposition s a prerequisite for interpreting trap catches, the elation between the numbers deposited and their oncentration in the air sweeping the surface has had cant attention. The problem has been studied here in connexion with epidemic crop diseases, and it has been shown that the size of the trap itself affects he catch to an extent greater than generally recognized.

When a plate or cylinder is placed with axis at ight-angles to the wind, Sell[1], working with droplets, as shown that as the size of the trap is increased an increasing proportion of the air stream is deected by the streamlines and fails to strike the trap. The percentage of particles deposited from the column air sweeping the surface gives a measure of the ficiency of the trap. The concentration of particles in the air can be measured directly with a power-operated suction trap such as the Cascade impactor[2] or a bubbler device. Efficiency can be shown to depend on particle size, wind speed and dimensions of trap. In a small wind tunnel operated at speeds between 1 and 10 metres per sec., the efficiencies of vertical cylinders of various diameters have been found to agree closely with the theoretical predictions of Glauert[3]. Table 1 gives illustrative values for *Lycopodium clavatum* spores (approximately 32 μ in diameter) based on wind-tunnel and open air tests, and for spores of *Lycoperdon giganteum* (approximately 4 μ in diameter) based on a small number of open-air tests only.

Table 1. Percentage Efficiency of Vertical Sticky Surfaces (wind tunnel and open air tests)

		Lycopodium		*Lycoperdon*	
Wind speed (m./sec.):	1	4·25	9·75	1	4·25
Vertical cylinder					
0·1 cm. dia.	73	80	80	—	—
0·53 ,, ,,	17·5	45	58	0·07	0·3
1·2 ,, ,,	2	25	38	0·03	0·1
Plate 0·65 ,, ,,	18	47	—	0·04	0·2
2·54 ,, wide	1	11	23	0·007	0·004

For horizontal plane surfaces, parallel to the air flow, such as the horizontal slides standard in pollen trapping, the principles of deposition are less clear. It is generally assumed that each particle-size is deposited by sedimentation at its characteristic terminal velocity[4], the trap being 100 per cent efficient. However, wind tunnel tests, illustrated in Table 2, show that anomalous values are obtained with horizontal glass slides. At wind speeds approaching 10 metres per sec. as many *Lycopodium* spores are deposited on the under surface of a horizontal slide as on the upper. Sedimentation under gravity must therefore play a minor part except at low wind speeds, and it is suggested that deposition is brought about largely by turbulent flow over the trap surface. The number deposited is, in fact, nearly proportional to the number of spores passing over the surface in a given time, irrespective of the amount of air they are diluted with, that is, irrespective of concentration.

Table 2. No. of *Lycopodium* spores deposited per min. from a cloud concentration of 10^6 spores/m.^{3} on horizontal glass plate 3 in. × 1 in. in turbulent tunnel

Wind speed (m./sec.):	9·2	5·6	3·2	1·7	1·1
Upper surface	140	78	12	15	43
Lower surface	140	27	15	2·4	0·27

Factors controlling deposition are evidently complex and not yet well understood. While a feathery grass stigma may catch pollen with high efficiency, many types of spore trap in current use are inefficient. Deposits on surface traps give direct information only on the amount of deposition on surfaces similar to themselves in dimensions and other properties. Although the intuitive belief that there is a general positive relation between deposition on a surface and concentration in the air is correct, the trap efficiency varies with conditions, sometimes widely enough to make a direct interpretation misleading.

P. H. Gregory
Rothamsted Experimental Station,
Harpenden, Herts.
May 26.

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[1] Sell, W., *Forschungsheft*, **347**, 1 (1931).

[2] May, K. R., *J. Sci. Instr.*, **22**, 187 (1945).

[3] Glauert, M., Aeronautical Research Committee, *R. & M.* No. 2025. (London, H.M.S.O., 1940.)

[4] Cocke, E. C., *J. Allergy*, **9**, 458 (1938).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, September 18—Friday, September 22

INSTITUTE OF METALS (at Bournemouth).—Forty-second Annual Autumn Meeting.

Monday, September 18

(In the School Hall, Bournemouth School for Girls, Gervis Road, Bournemouth), at 6 p.m.—Mr. E. E. Schumacher: "Communications Metallurgy".

Tuesday, September 19—Saturday, September 23

INSTITUTION OF MINING AND METALLURGY, in co-operation with the INSTITUTION OF MECHANICAL ENGINEERS, the INSTITUTION OF MINING ENGINEERS, the BRITISH IRON AND STEEL RESEARCH ASSOCIATION, and other bodies (at Ashorne Hill, Leamington Spa).—Conference on "Wire Ropes in Mines".

Wednesday, September 20—Saturday, September 23

SOCIETY FOR APPLIED BACTERIOLOGY (at the University, Nottingham).—Annual General Meeting and Conference.

ROYAL ASTRONOMICAL SOCIETY, Dublin Meeting.

Wednesday, September 20

(At the Royal Irish Academy, 19 Dawson Street, Dublin), at 6.30 p.m. —Informal Gathering of Fellows.

Thursday, September 21

(At the Royal Irish Academy, 19 Dawson Street, Dublin), at 10 a.m. and 2.30 p.m.—Astronomical Colloquium—a Discussion on "Problems of Solar Physics" (Chairman, Prof. H. B. Brück).

Friday, September 22

(At the Royal Irish Academy, 19 Dawson Street, Dublin), at 4.30 p.m. —Scientific Papers.

(In the Physics Theatre, University College, Dublin), at 8.15 p.m.—Sir Harold Spencer Jones, F.R.S.: Public Lecture on "Time".*

Saturday, September 23

(At the Royal Irish Academy, 19 Dawson Street, Dublin), at 10 a.m. —A Geophysical Discussion on "Planetary Atmospheres" (Chairman, Prof. L. W. Pollak).

Thursday, September 21

CHADWICK PUBLIC LECTURE (at St. Mary's Hospital Medical School, Norfolk Place, London, W.2), at 4.30 p.m.—Prof. J. Earle Moore (Johns Hopkins University): "The Public Health Aspects of Venereal Disease Control" (Malcolm Morris Memorial Lecture).*

Thursday, September 21—Saturday, September 23

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (in the Beveridge Hall, University of London, Malet Street, London, W.C.1).—Symposium on "Polymer Chemistry as Applied to Plastics".

Friday, September 22

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Exchange Hotel, Tithebarn Street, Liverpool), at 6.30 p.m.—Discussion on "Advantages and Disadvantages of Alkyls".

BIOCHEMICAL SOCIETY (in Derby Hall, The University, N. Mossley Hill Road, Liverpool), at 11 a.m.—Symposium on "The Biochemistry of Fish".

Friday, September 22—Monday, September 25

ASLIB (at the University, Bristol).—Annual Conference.

Saturday, September 23

BRITISH INTERPLANETARY SOCIETY, NORTH-WESTERN DISTRICT CENTRE (at the Adult Education Institute, 49 Lower Mosley Street, Manchester), at 7 p.m.—Mr. E. Burgess: "The First Moon Rocket".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICIST in the Department of Physics Applied to Medicine—The Secretary, Barnato Joel Laboratories, Middlesex Hospital, London, W.1 (September 23).

GRADUATE ASSISTANT FOR THE BIOCHEMICAL LABORATORY—The Superintendent, Children's Hospital, Western Bank, Sheffield (September 23).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 25).

CHIEF ENGINEER in the Ministry of Agriculture and Fisheries Research Vessels based on English ports—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3286 (September 26).

ASSISTANT TO THE DIRECTOR OF RESEARCH in the Department of the Chief Development and Research Officer—The Staff Officer (Ref. F/EV.143), London Transport Executive, 55 Broadway, London, S.W.1 (September 26).

TUTORIAL STUDENTSHIP IN PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (September 27).

CHEMISTS III at Royal Ordnance Factories in Scotland, South Wales and the West of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.536/50A (September 30).

FISHERIES AND RIVER POLLUTION INSPECTOR to take charge of the organisation and direction of work for the prevention of river pollution, and who should possess a good knowledge of all aspects of fish biology and river management and also of the law relating to salmon and freshwater fisheries—The Acting Clerk to the Avon and Dorset River Board, 35 The Canal, Salisbury, Wilts (September 30).

HEAD OF THE SECTION OF INSECTICIDES AND FUNGICIDES at the Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (September 30).

LECTURER (with special qualifications in invertebrate zoology or marine zoology or comparative physiology), and an ASSISTANT, IN NATURAL HISTORY—The Secretary, The University, Aberdeen (September 30).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER, male (Ref. C.488/50A): MECHANICAL ENGINEER having a sound knowledge of electrical engineering combined with experience in the design of light mechanical and electro-mechanical mechanisms, and a SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER, male (Ref. C.489/50A): ENGINEER with experience in both electrical and mechanical engineering, in a Ministry of Supply Research Establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 30).

LECTURESHIP IN ANATOMY—The Secretary, The University, Aberdeen (October 2).

PRINCIPAL PRODUCTION ENGINEER in the Admiralty Standards Section—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3284 (October 3).

JUNIOR LECTURER IN THE DEPARTMENT OF PHARMACOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (October 4).

SCIENTIFIC TECHNOLOGIST (Grade II) in the Records Section of the Scientific Department at London headquarters—The National Coa Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/252 (October 4).

READERSHIP IN MATHEMATICS at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C. (October 18).

PROFESSOR OF AGRICULTURAL CHEMISTRY—The Secretary and Registrar, University College of North Wales, Bangor (November 30)

AGRICULTURIST (with a University Degree in Agriculture or a equivalent diploma) for service in Yambio Agricultural Trainin School, Sudan—The Sudan Agent in London, Wellington House Buckingham Gate, London, S.W.1, endorsed 'Agriculturist, Yambio'

ASSISTANT DRILLING ENGINEER (with a degree in Mechanical o Mining Engineering, or equivalent Institute qualifications, and wit practical experience) for the Geological Survey, Sudan—The Suda Agent in London, Wellington House, Buckingham Gate, Londo S.W.1, endorsed 'Assistant Drilling Engineer'.

ASSISTANT ENGINEER (with power plant experience) for the Suda Gezira Board—The Sudan Agent in London, Wellington Hous Buckingham Gate, London, S.W.1, endorsed 'Sudan Gezira Boar Power Plant'.

ENGINEER-GEOLOGIST in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Offic Sanctuary Buildings, Great Smith Street, London, S.W.1, quoti No. 27079/18/50.

HEAD OF CHEMISTRY AND BIOLOGY DEPARTMENT—The Principa Norwood Technical College, Knight's Hill, London, S.E.27.

METEOROLOGIST, and an ASSISTANT METEOROLOGIST, Mauritius—The Director of Recruitment (Colonial Service), Colonial Offic Sanctuary Buildings, Great Smith Street, London, S.W.1, quotin No. 27118/11.

SENIOR LECTURER IN CHEMISTRY with high academic qualificatio in organic chemistry—The Principal, Chelsea Polytechnic, Manre Road, London, S.W.3.

WORKS ENGINEER required by the Division of Atomic Energ (Production), Capenhurst Factory, Chester, to be responsible for a factory engineering services—The Ministry of Supply, Division Atomic Energy (Production), Risley, Warrington, Lancs.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

B.I.O.S. Surveys. Report No. 24: The Pharmaceutical Indust in Germany during the Period 1939–1945. By J. B. M. Coppock. P 120. (London: H.M. Stationery Office, 1950.) 3*s*. 6*d*. net. [1

London School of Hygiene and Tropical Medicine. Report of Meeting of the Ross Institute Industrial Advisory Committee he in the Council Chamber of the Rubber Growers' Association on Tue day, 23rd May 1950. Pp. 22. (London: London School of Hygie and Tropical Medicine, 1950.) [2

British Society of Animal Production. Report of Proceedings the Twelfth Meeting, held at Cambridge, August 29th–Sept. 1st, 194 General Topic: The Livestock of East Anglia. Pp. 76. (Edinburg J. P. Maule, Secretary-Treasurer, King's Buildings, 1950.) 6*s*. [2

Department of Scientific and Industrial Research. Reports the Forest Products Research Board, with the Reports of the Direct of Forest Products Research for the Years 1939–1947. Pp. vii+94+ plates. (London: H.M. Stationery Office, 1950.) 3*s*. 6*d*. net. [2

Air Ministry: Meteorological Office. Meteorological Repor No. 5: Aviation Meteorology of the Route Castel Benito–Cai Pp. ii+46. (London: H.M. Stationery Office, 1950). 1*s*. 6*d*. net. [2

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UNIVERSITY EXPANSION IN GREAT BRITAIN*

THE report of the Ministry of Education on "Education in 1949" presents several features of interest to the scientific worker, apart from his general interest as a citizen, in its survey of primary and secondary education. First among these features may be mentioned an account of the work of the National Advisory Council on Education for Industry and Commerce on the further development of higher technological education in Great Britain, with special reference to the part which the major technical colleges could play. The Council considered that a wise policy would encourage the development of the excellent traditions that have been built up by the technical colleges in close association with local industries, and would encourage young people in industry to do their best by promising them an award as high as any that existed for their particular industry. An interim report on the future organisation of higher technological education has been prepared with these considerations in mind, and submitted for comment to the universities, local authorities, professional institutions, technical colleges, industry and interested government departments.

"Education in 1949" draws no clear distinction between technical and higher technological education, and there is nothing to indicate that the National Advisory Council appreciates the distinction that emerged so clearly in the third report from the Advisory Council on Scientific Policy, which supported the proposal to establish one or more colleges of applied science, with governing bodies of their own but fitted into the university system. The comments of the Advisory Council on Scientific Policy on this interim report issued by the National Advisory Council will doubtless appear in due course. Meanwhile, the Ministry of Education records steady progress by the regional advisory councils for further education, although there was little, if any, improvement in the accommodation for such education; the available accommodation tended to set the limit, and not the reluctance of employers to release young people, or the unwillingness of local education authorities to make arrangements. Indeed, one of the most striking features of further education in Britain since the War has been the steady rise in the number of young workers who are released by their employers during working hours, usually for one day or two half-days a week, to follow educational courses. In 1949 the total was 224,000, compared with 190,000 in 1948 and 167,500 in 1947. The five national colleges continued to make good progress, the Rubber College and the Heating, Ventilating, Refrigerating and Fan Engineering College completing their first year's work, and the Aeronautics and the Horology and Instrument Technology Colleges entering their third year.

Information in the report regarding the supply and training of teachers is rather meagre. The

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* Education in 1949: being the Report of the Ministry of Education and the Statistics of Public Education for England and Wales. (Cmd. 7957.) Pp. ix + 236 + 8 plates. (London: H.M. Stationery Office, 1950.) 5*s*. 6*d*. net.

Ministry does not normally obtain information about vacant posts in schools, and the only reference to the scarcity of qualified science teachers in the schools—a problem of much concern to the Advisory Council on Scientific Policy, which was also discussed at the Federation of British Industries' Conference on Industry and the Universities last November—is a statement that information from a variety of sources showed that many schools, especially girls' schools, had considerable difficulty in filling posts in science and mathematics with suitably qualified teachers. The seriousness of the present position, so far as teachers of science are concerned, was emphasized at the Birmingham meeting of the British Association, when the Division for Social and International Relations of the Association arranged a special discussion on the subject. The Ministry has already suggested to the National Advisory Council that the Council should investigate as an urgent matter the requirements of the schools for graduate teachers, and the best ways of meeting them.

One result of any such inquiry should be to help the Ministry to fix a date terminating the system under which university students receive grants as intending teachers for the whole of their university career, including their degree course, in return for a pledge "to take a course of training after their degree course and to take up the profession of teaching". It should be noted, however, that already more than two years have elapsed since the Working Party on University Awards made an emphatic recommendation that the system should be abolished "within the next three years". The other main determining factor with the Ministry is the development of an adequate system of university awards not earmarked for teaching or any other specific profession.

The chapter in the report dealing with the question of university entrance scholarships and other awards gives outstanding interest to the present report. Here is presented for the first time an account and appraisal of the Ministry's part in the Further Education and Training Scheme for Ex-Service Students, and an appreciation of the issues that are raised for the universities now that this scheme, which is correctly described as a large-scale, intensive and emergency effort to make good the educational wastage of the War, comes to an end. That end, while in sight, is still some way off, for, of the 8,641 awards taken up for the first time in the academic year 1949–51, any given for lengthy courses of training for medicine or dentistry, for example, will continue for at least six years, and 41,947 awards were still current at the end of 1949. Men called up for national service after September 1947 are not normally eligible for awards from the Ministry of Education, and during 1951–52 there are likely to be few, if any, new awards, other than those which for one reason or another have been held over from previous years.

Before the War, 16,000 out of 40,500 students were 'assisted'—roughly two in five—as against 38,000 out of 55,000 in the immediate post-war years—more than two out of three. During the past year, more than half the assisted students held other grants Of the 83,133 awards made by the end of 1949 22,314 were given to students likely to enter a branc of the teaching profession, 11,283 to students of som branch of engineering, 4,949 to medical students 2,350 for industrial chemistry, 1,196 for dentistry an 1,020 for pharmacy. Of the total, 43,741 were hel at universities ; 22,727 of them were current at th end of 1949, including 4,183 new awards made in th academic year 1949–50. From the beginning of th scheme in 1943 to the end of the financial year 1949–50, the cost is estimated at £33,500,000 o maintenance and £9,100,000 on fees.

With the termination of the Further Educatio and Training Scheme, students will have to rely fo financial help mainly on the future system of centra and local scholarships. Clearly, in the next two o three years there will be a sharp decrease in the rati of assisted students, or there must be a sharp increas in the number of new awards. The Ministry ha already plans to increase the present 900 awards t 2,000, and the supplemented awards made by loca education authorities are only 700 short of the targ of 2,000 set by the Working Party.

Nevertheless, although the Minister, in a circul issued to local education authorities last Octobe made it clear that arrangements for maintaining a adequate number of university awards should proceed concurrently with the termination of the furth education and training schemes, and that discussio between universities and local education authoriti on a new procedure for local awards in accordan with the Working Party's report should proceed, t Ministry's report sounds a note of caution. It is no of course, possible to equate the cost of the schen with its value judged by results, quite apart from t fact that what contribution to the country's welfa will be made by those who have been trained und the scheme remains to be seen. The Ministry h done well to arrange to maintain touch so far possible with those who have held grants under t scheme, with the view of finding out from them a few years time how their training has helped the in their careers. Nevertheless, as the report poi out, the fact that numbers of students who h obtained admission to courses of university stand failed in their studies is significant, and should borne in mind when questions of the expansion universities or of future scholarship policy are un consideration. In the face of that fact, it can scarc yet be maintained that the system of admissions universities is so nicely adjusted that the fact o candidate's admission alone justifies spending pu money on him. Hence, while universities must ca the responsibility for selecting students, it is desira that among themselves and in concert with schools they should seek to evolve new and m satisfactory means of selection, even if it me strengthening considerably the academic staff resp ible for selection.

The case for experiment in this field of selectio supported by the further observations in this re on university expansion. The fact that the uni sities have coped successfully with inflated num in a state of emergency does not of itself imply that numbers should necessarily be maintained at much the same level in the future. With the expenditure on university awards at a level of £40 million, there must be some relation between the number of university students and the number of graduates needed in our national life.

From this point of view the Advisory Council on Scientific Policy was altogether too restrained in its comments on the inadequacy of the Ministry of Labour's Survey of Scientific Man-Power. It is imperative that other means should be found of providing the type of information desired, and the Advisory Council could well have issued a firm recommendation or directive rather than expressed a faint hope. It may do no harm to assume for the present that the annual intake to universities should be maintained at its present level, and with it a level of output of graduates in science according with the recommendations of the Barlow Committee. Meanwhile, a gradual increase of open, State and local awards, as suggested in the Ministry of Education's report, may confirm the new opportunities suggested by the Further Education and Training Scheme, and go far to secure that well-qualified candidates are not debarred from a university education by reason of lack of means.

There should, however, be a limit to the term during which university expansion and university awards are not related to some reasonably accurate knowledge of the country's need of graduates. It also remains to be seen how large a number of students can attend universities and other higher institutions without depressing the general intellectual standard. Both he last report from the University Grants Committee and the statement from Nuffield College on the problems facing British universities indicated some oncern as to the maintenance of standards. One eason for placing on the universities the full responsbility for selection of students is that they would hereby be able to control their size, and thus ensure he maintenance of academic standards, by the number of recommendations for awards which they made.

Desirable as is such a policy, it carries implications which are not always recognized. For the universities t involves, as already indicated, a readiness to xperiment with methods of selection, so as to make hem as fool-proof as is possible, and to devote ncreasing time and care to the selection of students nd the difficult problems that may arise as between ne university and another, for which the idea of a niversity clearing house has been suggested as one possible solution. It means, too, that the essential ecisions regarding the expansion of the universities must have reference to some reasonably reliable timates of the number of students who are adeuately equipped to benefit substantially from a niversity training, and to the recognized needs of he nation for trained graduates. If in this way the olicy of university expansion and of university wards is firmly based on broad considerations of ational and social policy, the case for whatever ants are required to implement details of that policy could be cogently and convincingly argued at the national or the local level. There should then be little risk that the relatively narrower financial considerations would impede the making of awards.

ANIMAL ECOLOGY

Principles of Animal Ecology

By Prof. W. C. Allee, Prof. Orlando Park, Prof. Alfred E. Emerson, Prof. Thomas Park and Karl P. Schmidt. Pp. xii+837. (Philadelphia and London: W. B. Saunders Co., 1949.) 14 dollars.

THIS is a book of more than half a million words, with a bibliography of about 2,500 titles, and with more than three hundred text-figures and tables. Its five authors rank high among the exponents of animal ecology in the United States, and they have written of their subject not only at length but also comprehensively. Their book cannot fail to be a landmark in the development of animal ecology in this century.

After an introduction and a history of ecology occupying seventy-two pages, the material is arranged in four sections, each of which might stand as a separate work. The historical section represents the point of view of the Chicago school of ecology, to which active and influential group all five authors belong. The second section deals at length with the physical factors of the environment and briefly with some biotic factors. Although it covers much the same ground as the first part of Chapman's "Animal Ecology" (to which pioneer book the historical section scarcely does justice), this section is made useful by the inclusion of a good deal of modern work.

Section 3, on animal populations, will be welcomed by everyone interested in this field, for it supplies a long-standing want. Several recent reviews have summarized particular aspects of the subject; but here is a work of nearly a hundred thousand words bringing together a vast amount of information, and providing a well-balanced and authoritative discussion of it. This section should be reprinted as a separate volume so that it could come more readily to the attention of those concerned with human populations.

The largest section is entitled "The Community" and is an attempt to bring order to biotic ecology without recourse to the repellent lists of communities that fill page after page of some text-books. The subdivisions used are community structure, metabolism, periodicity, development and distribution. This approach represents a reaction from the recent American trend and a considerable return towards the arrangement that was used by Elton in his book of 1927.

The final section, on "Ecology and Evolution", ranges widely over some of the less tangible fields of biology and attempts to treat genetic variation, isolation, adaptation and natural selection from an ecological point of view. This aim involves a good deal of repetition, but was probably necessary to complete the authors' design. Readers who are not already acquainted with recent books by Mayr and others will find here many suggestive ideas.

There can be no doubt that this is an important book—important for the encyclopædic range of its contents, for the high authority of its authors, and for the influence it is likely to have on animal ecology, particularly in the United States. On that note, and with a strong recommendation to librarians and those who have need of a reference book of ecological data, it would be agreeable to stop. But it is a reviewer's duty to evaluate, and he may properly be asked whether, in the opportune circumstances, it is enough for this book to be important.

The great fault of the work is that it is grossly overloaded. One is led to the suspicion that the authors conceived themselves to be writing a text-book for the use of students without background of scientific knowledge who were to be saved the trouble of consulting any other work, whether of physics or geology or another science. Paragraphs such as those on Occam's razor (p. 5), gravity (p. 131) and vibrations produced by non-living forces in Nature (pp. 139–40), and elaborate statement of facts so obvious as that deer forage over wider areas than mites and that birds move greater distances than sloths (p. 490) not only steal space in the book and the reader's time but also raise doubts of the authors' judgment.

As a result of this overloading, and its consequent size, the book belies its title. If it does contain the principles of animal ecology, those beacons of which the subject stands so much in need, they have been smothered in facts of a low order of generality. It is mainly in this respect that the book, important as it is, fails to deserve higher praise. As an encyclopædia of animal ecology it will be used gratefully; but the authors owe us another book, with the title of this one and fewer than a fifth of its words, revealing what they conceive to be the principles of their subject.

GEORGE SALT

REVIEW OF ORGANIC CHEMISTRY

Recent Advances in Organic Chemistry

By Dr. Alfred W. Stewart and Dr. Hugh Graham. Seventh edition. Vol. 2. Pp. ix+447. 35*s*. net. Vol. 3. Pp. xi+387. 38*s*. net. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.)

ONLY Vol. 2 of the previous edition has been revised and extended into two volumes for the seventh edition, so that there is no Vol. 1 to this new edition. Vol. 1 of the sixth edition (1931) is out of print but "is no longer regarded as dealing with *recent* advances in organic chemistry and is therefore mainly of historical interest". It would have facilitated finding topics if each volume had contained lists of contents of the other two volumes. Perusal of the tables of contents of these two volumes reveals that three-quarters are devoted to natural products while one-eighth can be regarded as covering theoretical topics. Important though work on natural products has been, without doubt the outstanding advances of the past quarter of a century have been in theoretical organic chemistry, from the application of electronic concepts to molecular structure and reactivity and thence to the mechanism of reactions. In this light the division of material seems disproportionate.

Vol. 2 opens with an essay entitled "Organic Chemistry in the Twentieth Century". The reader has not far to go before encountering "By far the most interesting set of compounds prepared in the last quarter of a century has been the derivatives of various elements in a state of abnormal valency. Gomberg's triphenylmethyl seemed at first likely to remain without a parallel; but in recent times a perfect flood of abnormalities has been let loose . . . have forced upon the notice of chemists the fact that the old and apparently well-tried dogma of the permanent quadrivalency of carbon is in a very shaky condition"—rather disconcerting phraseology for 1950, while it is clear that the "last quarter of a century" refers to 1900–25. Then on p. 11, "During the last twenty years, the constitution of benzene has been discussed from almost every possible standpoint, and we are certainly not less wise than when the discussion began. Whether we are wiser is a more doubtful matter"—and the structure of benzene is not further referred to, and aromatic substitution is dismissed with a footnote reference to Holleman's book of 1910. On p. 18 it is stated that "In the whole field of stereochemistry no more puzzling phenomena are known than those grouped under the head of the Walden Inversion; and at the present day we still await a solution of the problem"—rather disconcerting in the face of the work of Hughes and Ingold and of others on aliphatic substitution reactions during the past fifteen years. In fact, the reader soon realizes that the title is a misnomer and that practically none of the theoretical development of the past twenty-five years are mentioned; and although the sections on natural products are rathe more up to date, little of the work of the past decad is described. Much that is already incorporated into text-books has yet to reach these volumes.

After chapters on carbohydrate constitutions and polysaccharides, attention is directed to the sesqui di- and tri-terpenes. The revision of the structure o cadinene in 1942 is not mentioned. The section o azulenes is rather unsatisfactory, particularly as thes can scarcely be regarded as terpenes, while n indication is given of the presence in Nature o *bicyclo*[5 : 3 : 0]decenes, which are true sesqu terpenes; in contrast, eleven pages are devoted t the as yet uncertain structure of caryophyllene.

The now established structure for pimaric acid pu forward in 1940 is rejected as "this alternative nee not be considered", while it is not made clear that pimaric and L-pimaric acids are not enantiomorph In two chapters on alkaloids one might expect t find mention of the total synthesis of quinine (1943) but this is absent, and groups of alkaloids whic have been actively investigated in recent years, fo example, that based on the *cyclo*pentenophenanthren skeleton, are ignored. The accounts of the antho cyanins, depsides and lignans are adequate, perhap because little work has been done on these groups i recent years. Vol. 2 is concluded by a long chapte on "Some Theories of the Natural Synthesis Vital Products" which appears to be substantiall the views of the late Prof. Collie in 1907, for n account is taken of the syntheses of alkaloids unde 'physiological conditions' by Schöpf during the 1930's developments in our knowledge of enzymes and the course of fermentations, or of the more recen views of Robinson. This chapter might well hav been omitted from the present edition.

Vol. 3 opens with chapters on the bile acids an sterols, vitamins, hormones and cardiac aglycones which give good accounts of the early work. Th section on vitamin A brings the story up to 193 although there is an appendix to this volume givin an indication of the synthetical developments i recent years. The chapter on hormones contains no mention of the adrenal gland, let alone the steroidal hormones of this gland which have excited so much interest in recent years—the sole entry in the author index to Kendall refers to his early work on thyroxine, while that to Reichstein refers to work on vitamin C. Chapters on porphyrins and azaporphyrins are good, and the latter probably gives the first collected account of the phthalocyanines. The chapter on "Synthetic Polymers and Condensates", in opening with "These substances may be viscous liquids, hard and glass-like or amorphous rubber-like solids", gives little hint of the important uses fibrous polymers have found in the textile industry, and the existence of nylon is only mentioned in the last sentence in the chapter. The chapter on "Rubber" might be expected to give some account of the spectacular developments during the Second World War of synthetic rubbers, but instead gives a long account of the controversies over the polymerization of isoprene during the first decade of this century that led up to the synthetic product of the First World War. The brief chapter on "Some Deutero-Organic Compounds" might well have been expanded into an account of the labelling of atoms in general, in organic compounds, both by 'heavy' and by radioactive isotopes, and their use in elucidating the mechanisms of biological and non-biological chemical reactions. A chapter on "Some Cases of Isomerism n Cyclic Compounds" gives an account of the early work on the geometrical isomerism of fused ring systems, for the case of the decalins, but fails to bring out the fundamental connexion this has with optical isomerism and ignores the work of Hückel and of Linstead during the 1930's. A chapter entitled "The Diphenyl Problem" gives a good account of the early work that led up to the recognition of stereoisomerism due to restricted rotation as a general phenomenon. n "Some Aspects of Stereochemistry" the optical activity ascribed to nitroparaffin salts is now known o be non-existent. A chapter entitled "Other Cases of Abnormal Valency" deals with what would now be described as free radicals of long life, although the better-known triarylmethyl type is not described, and he existence of such radicals is not regarded as proved—"Once the conception of free radicals is admitted, the long-tried dogma of the quadrivalency of carbon comes into the scales for a final test". The pening sentence of the chapter entitled "Some Applications of Electronics to Organic Chemistry" clearly indicates that only the ideas of the first uarter of this century are considered, and that there ave been developments since is only hinted at in a otnote. Vol. 3 concludes with chapters entitled "Structural Formulæ and their Failings" and "Some Unsolved Problems", which having served their purpose in earlier editions might well have been mitted from this edition.

It is not clear to the reviewer the purpose these olumes are intended to serve. The advance of rganic chemistry is so rapid to-day that successive ditions of a book of this type, particularly after an terval of nearly twenty years, would be expected contain largely fresh topics, the material of the evious edition having by then been incorporated to text-books. Certainly the sections on theoretical pics are inadequate if not misleading; their deletion ould give room to bring those on natural products to date. Then, with the fuller detail thus given, ese volumes would be of value to students in proling a bridge between the necessarily abbreviated accounts in general text-books and the terseness of the "Annual Reports" or the "Quarterly Reviews" of the Chemical Society.

In general, the author index does not discriminate between authors of the same surname, and the reviewer disclaims credit for most of the work ascribed to him.

S. H. Harper

THE BOOK OF A BIRD-LOVER

In Praise of Birds

By Dr. Charles E. Raven. Pp. 206+17 plates. (London: George Allen and Unwin, Ltd., 1950.) 15*s*. net.

THE publication of this book, with its title of great charm, is something of a landmark, because it is a selection of some of the best bird papers which the gifted author has published during the past twenty-five years, enriched by some capital photographs. Among the illustrations, surely the most remarkable is that of a long-tailed drake in summer plumage, photographed in June, off Scourie, on the north-west coast of Scotland. To see, let alone to approach so near as to be able to photograph, a bird of the Arctic in June in British waters is unusual. That small drake must have been exceptionally tame, for it was obviously photographed at close range.

From Texel, with its wonderful population of wading birds, we follow the author northward, or more correctly north-west, to the rocky fastnesses of Foinne Bheinn and Arcuil (had the book been about animals, we might have been told about the legendary fork-tailed deer of Arcuil) in the remote Reay Forest, home of the golden eagle, of the greenshank and of the black-throated diver. (The black-throated diver did not nest until June this year, and, as almost always, lost her two eggs through her small nesting island being submerged by a sudden rise in the level of the loch, following on a day of heavy rain.) In the Reay Forest the author had an adventure with a golden eagle. It was only this summer that I was told by John Scobie, the hero of the tale (he spells his name, by the way, with only one 'b'), further details of that adventure, and he pointed out the rock on which the eagle nested on that occasion—the great bird does not now occupy that site, although it is still in the neighbourhood, and was seen to carry to another eyrie a full-grown heron. The author (p. 199) asks why the common heron, obviously a marsh builder, should nest in trees. This has always puzzled me, and when on the Hebridean island of Colonsay I was shown a heron colony in the reeds of a loch, I thought how much more in keeping with their surroundings were the long-necked and long-legged birds there than on the tree tops where, on the mainland of Britain at all events, the species habitually nests.

When the author asks whether a bird may not perhaps have psychic sensitiveness, he finds himself in sympathy with the reviewer of his book, for it is unlikely that the human race should have the monopoly of psychic awareness.

"In Praise of Birds" is packed with good things. The style, as might be expected, is simple yet vivid; and the reader finds himself being held by one chapter after another, so that he lays aside the book with reluctance.

Seton Gordon

The Avian Egg

By Prof. Alexis L. Romanoff and Anastasia J. Romanoff. Pp. xiii+918. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 84*s*. net.

PROF. and Mrs. Romanoff have long been widely known as leading authorities on the biochemistry of the avian egg. In this exhaustive book they have brought together all that is known about the physiology of laying, the formation and structure of the egg, its physico-chemical properties, and its employment in the food industry. Although embryological considerations are excluded from the frame of reference chosen, the book will be indispensable for all who are concerned with the biochemistry of development and morphogenesis, since it unfolds the whole panorama of the very complex assembly of chemical substances which have to be made ready by the parent organisms for what one might call 'zero hour'.

The illustrations, many of which have been prepared especially for the work, are clear and excellent. No less than 2,600 references to original literature are assembled, and the index is adequate. Perhaps it is ungrateful to refer to them, but I do not like the somewhat sententious statements of the obvious which are dignified by italics as mottoes at the head of each of the chapters, nor do the symbolic charts (for example, that on p. 490) add anything helpful.

It seems a pity that, in the section on industrial uses, the authors did not include a chapter on the large-scale commercial incubation of eggs in the poultry industry, about which they probably know as much as anyone living; but doubtless they are reserving this for a companion volume of another thousand pages. In a second edition, it would be desirable either to expand the treatment of the place of the egg in folk-lore and philosophy, or else to delete the last few pages on "traditional uses" of eggs, which are trivial and form an anti-climax to an otherwise worthy work. JOSEPH NEEDHAM

Logical Positivism and Ethics

The Symposia read at the Joint Session of the Aristotelian Society and the Mind Association at Durham, July 9–11, 1948. (Aristotelian Society, Supplementary Vol. 22.) Pp. iv+215. (London: Harrison and Sons, Ltd., 1948.) 21*s*. net.

THESE essays are characteristic of the Symposia Reports issued from time to time by the Aristotelian Society. In this case they emanate from a joint session with the Mind Association. While not professing to settle anything, they are the result of philosophers thinking aloud among themselves. There are four parts dealing (in brief) with language, the emotive theory, logic, things and persons. In addition, there is an address on the theme of ethics without propositions. This reaches the broad conclusion that moral philosophy can be interpreted in a new way, though the 'risk' of making morality subjective is foreseen.

Prof. K. R. Popper produces the interesting remark that philosophical problems perhaps contain an empirical, as well as a logical, component; Mr. W. C. Kneale, however, is not convinced that this explains what is meant by logic, or how it can serve philosophy. Such are age-long questions, incapable of short answers. Prof. H. A. Hodges makes the valuable point that our present scientific outlook is probably inimical to a due respect for persons. Some there be that realize this, whereas 'other some' (to recapture a phrase used long ago at Athens) do not.

Dr. J. O. Wisdom is much concerned about the difficulties of 'taking ethics seriously'. But he throws out the intriguing suggestion that certain kinds of science, philosophy and art reveal what is hidden in the obvious. F. I. G. RAWLINS

The Science Masters' Book

Series 3, Part 1: Physics; being Experiments selected from the *School Science Review*. Editors G. H. J. Adlam, S. R. Humby and G. N. Pingriff. Pp. xviii+318. (London: John Murray, 1950.) 15*s*. net.

ALL teachers of physics will give a hearty welcome to the new issue of this well-known and extremely useful book, which contains experiments selected from the *School Science Review*, covering the period 1937–45. More than two hundred experiments are included, and nearly half of these deal with electricity, though all branches of physics are generously represented. In their choice of contributions the editors have certainly moved with the times, for the increase in space given to electricity is accounted for mainly by wireless and the cathode ray oscillograph, an instrument which the editors rightly say will probably be much used in the future in schools. Then again, more space is taken up than in previous issues by notes on the construction of new apparatus. This development of making apparatus has probably been forced upon schools by the war-time dearth of apparatus, and it certainly has its advantages.

Apart from appreciating the help which the book gives to teachers and students, one is struck by the enthusiasm and interest of the contributors—some old, others new—in their jobs, and one feels that while we have men of this calibre the teaching of science in our schools is safe; however, one is tempted to ask, with a certain amount of misgiving, what about the future?

This is an excellent book which should be in the hands of all teachers of physics in all institutions where science is taught.

Rarer Metals

By J. de Ment and H. C. Dake. Pp. xv+34 (London: Temple Press, Ltd., 1949.) 25*s*. net.

THE original of this is an American book by the two authors named. This has been revised and extended by E. R. Roberts and R. C. Williams, who have added chapters on the rarer alkali metals, calcium, barium, rhenium and boron. In the American book practically only American sources of minerals were mentioned, more important sources elsewhere being completely ignored. This tendency has not been adequately rectified in the present edition, and it very seriously diminishes its value. In other cases where some additions have been made only foreign materials have been mentioned, as in the case of the alloy steels for permanent magnets.

The book is essentially a compilation and is often uncritical; but it has a considerable value and gives a large amount of information not easily found elsewhere. The older German books, which such American books as this are supplanting, usually took account of work without preoccupation about its country of origin, and for that reason have a permanent value the newer books cannot achieve. J. R. P.

A BIOCHEMICAL APPROACH TO VIRUSES

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VIRUSES fall between two stools; but virus workers, instead of settling comfortably on the floor, try to maintain precarious positions on the stools. The stools are, of course, the chemical criteria suitable for the study of simple molecules such as vitamins and most hormones, and the biological criteria used with micro-organisms. Pragmatically the distinction is between the experimental methods that are characteristic of a biochemical, and of a purely biological, laboratory. We all agree that *Bact. coli* is an organism; but when it is being disintegrated to make an enzyme preparation or hydrolysed as a prelude to amino-acid analysis, it is being treated as a substance and, but for the preliminary agreement, might be looked on as a molecule. The position with viruses is similar. No one has demonstrated that some of them are 'substances' or 'macromolecules'. Indeed, such a thing is not susceptible of demonstration; it is not a statement about the viruses, but about the mental approach and technique of the research worker.

The use of biochemical methods in the study of viruses has contributed greatly to knowledge; but t has brought with it a danger of over-simplification. The application of some chemical methods to the study of a group of substances does not guarantee he amenability of these substances to all other chemical criteria. Thus, when one has produced a convincing mass of evidence that one of the smaller molecules has a certain constitution, it is generally agreed that this evidence excludes all other contitutions that are not equilibrium states of the first. But at the other end of the scale—on the other stool o use the original metaphor—this is not so. It is obvious that the zoological or botanical criteria for species can often be satisfied by individuals covering considerable range of size and shape and colouring, nd this is also true of bacteria. If we rank biohemical and biological objects in order of size, it is ot necessary to go so far along the size-scale as this o find variable structure associated with essentially he same activity. Distinguishable pepsins are laborated by the same species, and even the same ndividual may make a mixture of antibodies as a result of the stimulus of what appears to be a single antigen. In many of these instances we know somehing of the factors that affect the properties, for example, environment or the route chosen for the njection of an antigen; but the fact remains that n this region of the size-scale an entity to which it convenient to attach one label may not have nique properties. The viruses lie in the middle of his region; it is therefore probable that they too ill be variable. The smaller viruses make an admirble prelude to biology; we see here a rudimentary orm of the broad biological principle that the same nal result can be achieved through the action of ents that are not chemically identical in the ideal ase.

The characteristic properties of viruses make any equivocal demonstration of the nature of the fective particle difficult. In chemistry and in cteriology the range of possibilities can be limited synthesis or by the use of 'Koch's postulates'. Of e latter the most important is that the agent must cultivated outside the host. Viruses cannot be cultivated in this way—perhaps, with the larger ones, for purely technical reasons that may be overcome; with the smaller ones the host is probably not just an alternative medium, as with most bacteria, but is an essential part of the virus-making mechanism. Cultivation in a medium that is not known to have any activities of its own if left uninoculated is an essential phase in the characterization of a disease-causing organism; it is the biological counterpart of synthesis in the chemical domain; it serves, like synthesis, to reduce enormously the risk of an unsuspected contaminant being the actual cause of the effects that are being studied. There are diseases where analogy is so strong, for example, malaria and the rusts of wheat, that it is unreasonable to insist on cultivation *in vitro* before accepting the ostensible cause as a real cause, but with the smaller viruses there is no such analogy. We have generally no means of knowing what proportion of the particles in a preparation is infective, and we cannot assume that the more infective of two preparations is the more nearly in its original state. Thus Bawden and Pirie[1] found that, by suitable treatment *in vitro*, the infectivity of preparations of one of the tobacco necrosis viruses can be greatly enhanced. They also found a characteristic nucleoprotein that did not appear to carry any infectivity at all. This may be analogous to the non-infective phase that Hoyle[2] has observed with influenza virus, and that Bauer[3] has postulated with other viruses.

There being no canons to guide research on the smaller viruses, the research worker is in the pleasant position of having to fall back on his intelligence, and keep all lines of evidence in mind without trying to use any particular one as a touchstone. It has been apparent since Bawden and Pirie showed that a series of plant virus preparations consisted predominantly of nucleoprotein that an aberration of nucleoprotein metabolism was the most characteristic feature of these plant virus infections. The earlier work of Schlesinger[4] and Craigie[5] on a bacterial virus and vaccinia had indeed already made this probable. The point has been generally accepted; it may be that it has been too readily accepted, and that a sufficiently sharp look-out is no longer being kept for preparations that act like viruses without containing significant amounts of nucleoprotein. Claude Bernard remarked: "Anatomy localises Physiology"—so also biochemistry limits biology. It shows quickly in which broad chemical field the immediately apprehensible aspects of the problem lie. Most people would agree that plants suffering from certain virus infections contain large amounts of nucleoproteins that are either absent from, or trivial constituents of, the uninfected plant. They would also agree that preparations consisting largely of this anomalous nucleoprotein can initiate a new infection. Is there any *a priori* reason for assuming that infection can lead to the production of only one anomalous nucleoprotein or that the ability to initiate infection in a new host is a property restricted to one ideal unique structure? Clearly there is not. Structures so similar that they are with difficulty distinguishable experimentally are likely, for this reason, to be confused by an organism, whether it is synthesizing the structure or responding to it. In the absence of evidence it is only reasonable to assume that infection leads to the synthesis of a range of similar substances, and before the process of infection can be comprehended biochemically they must all be investigated. They may not all be able to initiate infection under all conditions, and there is no reason to assume that even the infective particles are of uniform composition. Only parts of a particle as large as a virus may have to make a steric fit with the host. The back of the particle may be so far from the synthesizing surface that it will only have to meet general mass and charge specifications. Small molecules do not have backs; the disposition of mass and charge in any part of the molecule is perceptible at a surface on which it is adsorbed. The observed specificity of structure needed for drug or hormone action does not therefore give any reason for assuming that there is an equal specificity for virus action.

Analytical techniques have not yet developed so far as to make it profitable to look for variations in the composition of viruses. Their sizes, however, have been extensively studied, and the results with tobacco mosaic virus illustrate clearly the difficulties encountered. The original length proposed for the particles in tobacco mosaic virus preparations was 1400–180 mμ[6]. This size-range was deduced from the properties of purified solutions, and emphasis was laid on the fact that the processes of purification so greatly enhanced those properties of a tobacco mosaic virus solution, generally attributed to the rod-like nature of its particles, that it was reasonable to assume that there had been linear aggregation. In several later articles this has been re-emphasized[7,8,9,10]. By working quickly and by avoiding treatments known to cause aggregation, preparations have been made[11] that are much less aggregated but that can be aggregated by exposure to many agents, including the sap from normal or infected leaves. A series of preparations was made by ultracentrifugal fractionation, each of which consisted predominantly of an anomalous nucleoprotein which could aggregate to give material similar in its physical and serological properties to tobacco mosaic virus preparations made by the usual dilatory methods.[1] These fractions differed in infectivity; on electromicrograms of the more infective fractions, Crook and Sheffield[12] found a larger proportion of particles approximately 280 mμ long than in those fractions carrying less infectivity. But fractions containing few rods of this length carried infectivity, and this was not increased when they underwent aggregation. Many interpretations of these phenomena are possible. If there were any reason to assume that infectivity is a property confined uniquely to one type of particle, it would be reasonable to choose 280 mμ as its approximate length and then to invoke activating and inhibiting powers in the shorter particles to explain the infectivity of preparations containing few rods of this length and the absence of an increase in infectivity when the proportion of 280 mμ material is increased by aggregation. In the light of the argument set out earlier in this article, it seems easier not to make the initial, improbable, assumption.

The recognition by Crook and Sheffield[12] of 280-mμ rods in some preparations protected so far as possible from aggregation, and the corollary that these rods probably also exist in the infected leaf, gains support from the evidence that Wilkins *et al.*[13] have given that this is the length of the particles from which the crystals often found in hair cells on infected tobacco leaves are made up. Unfortunately, the information that can be got by their technique sheds no light on the questions over which there is any uncertainty: What proportion of the anomalou nucleoprotein in the tobacco mosaic virus infected plant is in each state of aggregation, and how is the infectivity distributed between those different states The composition of these intracellular crystals is still uncertain. There is no reason to doubt that they contain nucleoprotein similar to or identical with the main component of a tobacco mosaic virus preparation, but they can scarcely be made up exclusively of this, because it is soluble at much greater concentrations than can reasonably be postulated in the hair cells. Tobacco mosaic virus preparations do however, form paracrystalline complexes with a range of substances, some of which are components of sap[14,15]. It seems probable that the intracellular crystals are of this type, and that they can no more properly be called crystals of virus than salt crystals can be called crystals of sodium. Their properties are presumably mainly dictated by the major component, but the nature of the minor component is both a matter of interest and of importance. It is of especial importance because in a heterogeneous nucleoprotein mixture, such as is postulated, it is likely that certain components will be precipitated preferentially. The study of crystals in hair cells is of value, and Wilkins *et al.* describe several phenomena of interest to the microscopist and crystallographer but an examination of the state of part of the nucleoprotein in structures that make up less than 0·1 per cent of the weight of the leaf gives hints rather than evidence about the properties of the remainder of the nucleoprotein in the other 99·9 per cent of the leaf

If it is agreed that an important feature of infection with tobacco mosaic virus is a gross derangement o nucleoprotein metabolism, it must follow that in gaining an understanding of the mechanism of infection all the anomalous nucleoprotein must b studied. Attention must not arbitrarily be restricted to one size and shape of particle out of the rang that is indisputably present in the infected plant Some of this nucleoprotein may be wholly irrelevant some may be breakdown products of the virus, some may be component pieces of virus awaiting assembly in the manner that Luria and Dulbecco[16] hav postulated for a bacterial virus, and some may be the virus itself. But the term 'virus' should be use with circumspection, for we have no means of defining criteria for its rigorous use. Its simple unqualified use, especially in experiments like those of Wilkin *et al.* in which no infectivity measurements hav been made, is to be deplored. It is apt to lead the reader astray, and it is possible that it may lead the authors astray also.

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FOLDING AND UNFOLDING OF PROTEIN MOLECULES IN RELATION TO CYTOPLASMIC STREAMING, AMŒBOID MOVEMENT AND OSMOTIC WORK

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IN this article evidence is presented that, in the amœba, protein molecules fold up at one end of the cell and unfold at the other, and that this results in cytoplasmic streaming and in osmotic work.

Amœboid movement is of considerable interest, since it is not only a feature of a group of Protozoa but is also a fairly general property of cells when they are unconfined by neighbouring cells or rigid envelopes. Further interest is added because it appears that, in mitosis, the division of the cytoplasm just after the division of the nucleus may be the result of two oppositely directed amœboid movements within the parent cell.

Various theories have been proposed[1,2] to account for amœboid movement: local differences in surface tension; a rhythmic contraction of the cell membrane; contraction of the cytoplasm due to gelation; a difference of pH, or of water content, between the front and rear of the cell, and so on. While there may be a germ of truth in some of these, they either conflict with experimental facts at some point or are quantitatively inadequate to account for the amount of movement that takes place.

It is now generally agreed that amœboid movement is due to the contraction of the cortical gel at the rear portion of the cell. After contracting, the gel liquefies and the resulting sol is squeezed forward along the central channel of the cell to form more gel on the walls of the advancing pseudopod.

Fig. 1 shows the same cell photographed at short ntervals of time in three successive positions. Two pseudopodia at the rear of the cell are fixed points of reference, remaining stationary on the slide. It can be seen that the membrane on the left of them becomes greatly reduced in area in half a minute. The membrane must be dissolving, for otherwise the cell would soon become filled with it. The part that s dissolving (tail) has a wrinkled appearance rather ike the appearance of a monomolecular layer of protein or lipo-protein seen under the microscope fter it has been collapsed by compressing it on a Langmuir trough. Solution of the membrane is robably due to the folding up of its protein molecules nto the globular form[3] as a result of two-dimensional ompression arising from the contraction of the ortical gel attached to it.

The tail is a relatively permanent part of the cell, contrast with the advancing pseudopod and the dventitious lateral pseudopodia. The membrane at he tail is much more firmly attached to the cytoasm than at any other part of the cell. This can be monstrated by a wide variety of reagents. When nœbæ in a hanging drop are exposed to the vapour practically any volatile fat-soluble substance, ch as chloroform, ether, benzene, hexane, phenol, hanol, and, notably, osmic acid, the membrane lifts away from the cytoplasm by about a quarter of the cell's diameter, except at the tail, where it remains attached.

The gel in the tail liquefies after it has contracted to about a quarter of its original length. It appears as though it contracts as a result of some substance secreted on to it from a body in the tail—a 'tail organiser'. As the tail advances, it liquefies each part of the cortical gel in turn. The tail is pulled forward continuously by the contraction of the cortical gel attached to it.

Working Hypothesis

It is likely that the protein molecules in the liquid part of the cytoplasm must be folded up, since almost all known proteins gel when unfolded (for example, by heating), when in as high a concentration as they occur in cells (that is, about 10–20 per cent). The protein molecules in the gel would be unfolded in order to form an interlocking network of fibres. The change from gel into sol as a result of the folding-up of the molecules would thus cause a contraction during the first part of this process, as shown in Fig. 2.

A diagrammatic representation of the protein molecules in the amœba would be as shown in Fig. 3.

The sizes of protein molecules make it feasible to handle them diagrammatically as shown here; for the length of an amœba (0·3 mm. for *A. discoides*) could be spanned by the unfolded polypeptide chain of a protein molecule of molecular weight 100,000,000, and the cortical gel would correspond to the thickness of about 10,000 wet protein monomolecular layers.

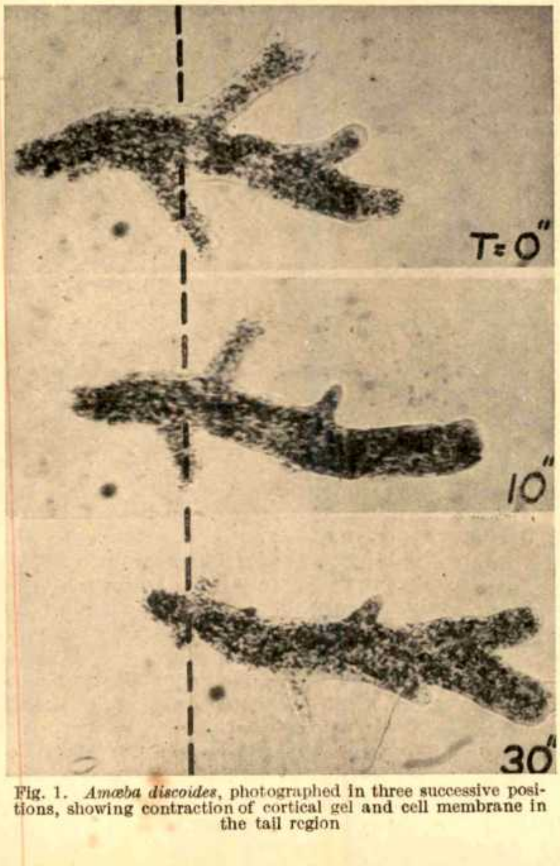

Fig. 1. *Amœba discoides*, photographed in three successive positions, showing contraction of cortical gel and cell membrane in the tail region

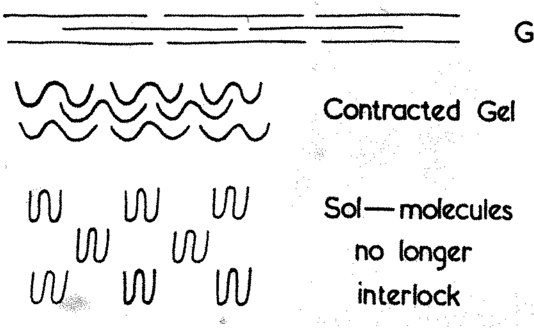

Fig. 2. Diagrammatic representation of the folding-up of protein polypeptide chains in the protoplasm

Testing of Model

The model postulated for the cell predicts the existence of certain phenomena :

(1) *Osmotic work, that is, the concentration of material against a concentration gradient.* When protein molecules are unfolded, they have more surface area available for the adsorption of other molecules than when they are folded up, since the side-chains used to hold one part of the polypeptide chain to another part in the folded globular molecule become free and turn towards the solution and can then adsorb other substances. In accordance with this, it was found that egg albumen adsorbed eight times as much dye when unfolded as a monolayer as when in a globular form in solution ; similarly, Oster[4] has found that tobacco mosaic virus increased its uptake of dye 300 times when denatured. This difference between ovalbumin and the virus is to be expected, because larger molecules have a higher proportion of the side-chains buried within the molecule.

In the amœba, the unfolded molecules in the cortical gel should adsorb the material from the environment, and when they fold up in the tail they should desorb it. Thus, in time, a large amount of material should be released into the tail.

Amœbæ were placed in a dilute (0·01–0·001 per cent) solution of Neutral Red, and within a few minutes accumulated the dye in their tails, but only when actively streaming. The advancing pseudopod was always colourless. Amœbæ which were not streaming, however, became stained uniformly around the periphery. This shows that the colour in the tail is not due to a stainable body there, but is a function of the movement of the cell. When a cell died or became cytolysed, the whole of the cytoplasm became quickly stained, much more intensely than when alive. This shows that the whole of the cytoplasm is stainable, and that it has a mechanism for releasing itself from the dye it has taken up.

The protein released from the dye streams forward and takes part in further accumulatory cycles. Why the Neutral Red does not stream forward with it is not clear. It does not appear to be trapped in a vacuole, as in plant cells (*v.i.*), but when in high enough concentration causes some small local precipitation of protoplasm, which can be felt as a hard lump with the microdissecting needle. When the cell is in a solution of lower concentration, however, the Neutral Red does stream forward with the cytoplasm and eventually appears distributed in what have been called "neutral red vacuoles"[5].

(2) *Contraction induced by adenosine triphosphate.* The changes occurring in the amœba's tail are paralleled by the action of adenosine triphosphate on the actomyosin gel. Thus, addition of adenosine triphosphate causes the liquefaction of the actomyosin gel, and the contraction of an actomyosin fibre[6]. Accordingly, a 1–3 per cent solution of adenosine triphosphate, adjusted to pH 7 with sodium hydroxide, was injected into the amœba, with the following result : (1) when injected into the tail, the speed of streaming of the amœba and the area of the wrinkled tail region was increased several times ; (2) when injected into the advancing pseudopod, the streaming of the amœba reversed ; (3) when injected into the centre of the amœba, it became crinkled all over and developed a kind of rigor. With larger amounts the cell rapidly put out pseudopodia and withdrew them all over its surface. This was reminiscent of the 'bubbling' which occurs in amœbæ and in tissue culture cells during the final stages of nuclear division. Since prodding the cell causes some disturbance, control injections were carried out with distilled water and various salt solutions, but without effects comparable with those of adenosine triphosphate.

The effect of adenosine triphosphate lasted less than a minute and the substance could be injected repeatedly to produce the same effect. In contrast with distilled water and physiological salt solution, which tended to be pinched off as a bubble, adenosine triphosphate mixed with the cytoplasm and was remarkably innocuous.

(3) *Liquefaction by heparin.* In the advancing pseudopod the cytoplasm clots on the freshly formed membrane to form new cortical gel. Injection of the anticoagulant, heparin, was found to prevent this process. The cytoplasm liquefied at the site o injection of a 0·1 per cent solution, and the pseudopod extended from that spot was spherical, not cylindrical indicating the absence of cortical gel. The whole o the cell poured out into this spherical pseudopod Injection of heparin thus acts as an additional contro experiment.

Summarizing, adenosine triphosphate and heparin have opposite effects : adenosine triphosphate cause

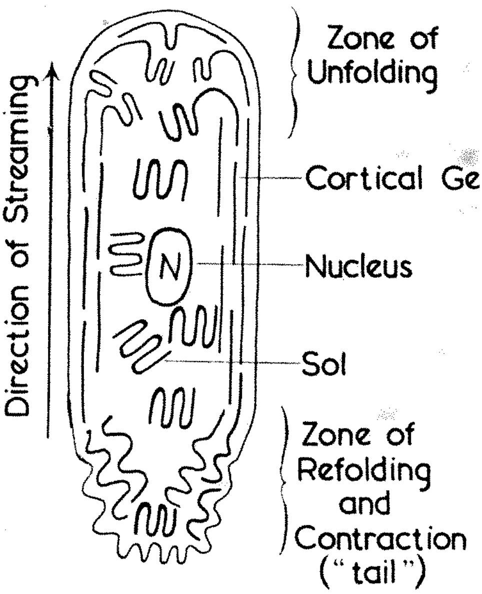

Fig. 3. Diagram of an amœba, showing the degree of folding of the protein molecules at various parts of the cell

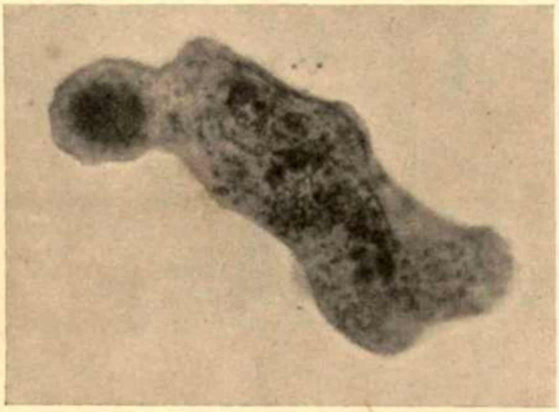

Fig. 4. *Amœba discoides*, after streaming for 15 minutes in 0·003 per cent Neutral Red solution, showing accumulated dye in the tail (left-hand top)

the motion of the cytoplasm away from the site of injection, and heparin causes motion towards it.

Discussion

It is tempting to speculate about the chemical details of this contraction process. One might imagine an enzyme in the tail (the 'tail organiser') producing a substance like adenosine triphosphate from a precursor widely distributed in the cytoplasm. The 'tail organiser' gradually becomes exhausted and the cell rounds up prior to division. Cytoplasmic movement is not conspicuous again until nuclear division takes place. The 'resting' nucleus has meanwhile made two 'tail organisers', and throws these out when it divides, releasing at first large quantities of adenosine triphosphate-like substance. This causes 'bubbling' of the cell and eventually contraction of the cortical gel in the cleavage furrow. The cytoplasm is 'revitalized'[7], and the two nascent daughter cells, now having tail organisers, move apart by ordinary amœboid movement, at first as parts of the parent cell, and later as separate individuals. In support of this is the fact, revealed by speeded-up microcinematography (of fibroblasts in tissue-culture, as well as of amœbæ), that the tails of the daughter cells originate from the cleavage furrow of the parent cell.

The advancing stream of cytoplasm from the tail flows over the nucleus, which maintains a central position. The nucleus increases in size during cytoplasmic streaming. It appears to alter the plasmasol in such a way that it can gel again on the walls of the advancing pseudopod. Enucleation of the amœbæ causes a temporary bubbling, and afterwards the cell streams only feebly and intermittently[8,9]. When the nucleus is put back the cell resumes continuous and vigorous streaming within a short period[9,10]. Thus, a function of the nucleus—apart from the part it plays in heredity—appears to be that of a depolarizer, in the same way as the depolarizer in the electric cell (the current is weak and ntermittent without the manganese dioxide or other oxidizing agent, but strong and continuous with it). The nucleus may collect the adenosine triphosphate-like substance and its breakdown products secreted by the tail (hence the 'bubbling' of the enucleated amœba), accumulating this material and resynthesizng from it two tail organisers which it ejects at uclear division. It may be that the division of the nucleus is triggered-off by the accumulation within it of more than a critical concentration of these adenosine triphosphate breakdown products. This is supported by Schaeffer's[11] observation that amœbæ divided on an average every two days, but if one of the two daughter cells resulting from a particular division divided earlier than this, then the other usually divided later. This suggests that some substance connected with the triggering of mitosis is occasionally divided unequally. However, it is unwise to take this speculation too far without chemical data on the distribution of adenosine triphosphate-like substances between nucleus and cytoplasm at various stages from one division to the next.

Some Generalizations

The question arises whether protein-folding is a special arrangement met only in the amœba or a general phenomenon occurring in other cells. It certainly appears that the same process goes on in other types of cells although in a different geometrical guise. For example, in the root hairs of plants there is a vacuole near the tip over which cytoplasm streams, bodily reversing its direction about every five minutes. Cytoplasm and vacuolar membrane, being in contact, move practically together so that the membrane moves away from one end of the vacuole and would accumulate at the other, unless it dissolved there. Presumably the protein molecules are folding up at the end of the vacuole towards which the cytoplasm streams. In support of this it was found that Neutral Red accumulated there when various roots were placed in a solution of the dye. Then, on reversal of streaming, it accumulated at the other end.

Again, in the septate hyphæ of the mould *Neurospora*, Neutral Red accumulated at the end of each cell, as in amœbæ.

Speeded-up cinematography reveals that fibroblasts in tissue culture are like amœbæ in which the various contractile elements have been liberated from the cortical gel and have gained a measure of independence so that they are not all forced to contract at once. It might be expected that each contractile element in the cell would act as an independent accumulatory mechanism, and in support of this it was found that chick fibroblasts in Neutral Red solution accumulated the dye within half an hour, in three or four diffuse clouds at various parts of the cell.

The protein molecule is unique in that its chemical and physical properties are greatly altered by changes in the degree of folding of the polypeptide chain. That this property might be exploited in living cells and be the basis of many vital phenomena has been suggested, especially by Astbury[12] and Szent-Györgi[6]. The reversible conversion of a mechanical into a chemical effect, by pulling a protein molecule undone so as to expose new side-chains to the solution, might conceivably be the basis of protoplasmic movement in general; of secretion, especially where, as in renal and gastric secretion, osmotic work is a major feature; and even of electrical effects across membranes, as in the electric organs of fishes, muscular contraction and nervous conduction where any folding of protein in the surface would be expected to change the potential across it.

A more detailed report will be published elsewhere.

We wish to thank Profs. A. Haddow and J. F. Danielli for their interest and encouragement. We are indebted to Sister Carmela Hayes for a culture of *A. discoides*, to Dr. Charity Waymouth for the tissue cultures, and to Mr. F. S. Speed and Mr. M. S. C. Birbeck for the cinematography. The work was carried out during the tenure by one of the authors (R. J. G.) of a grant from the Forsyth Bequest of the Royal Society, and was supported by grants to the Royal Cancer Hospital from the British Empire Cancer Campaign, the Jane Coffin Childs Fund for Medical Research, the Anna Fuller Fund, and the Division of Research grants of the U.S. Public Health Service.

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PRESENTATION OF TECHNICAL INFORMATION

THE discussion at Birmingham, on September 1, arranged jointly by Sections A (Mathematics and Physics), G (Engineering) and J (Psychology) of the British Association, on the presentation of technical information attracted an audience in which other sections, notably chemistry, were also well represented. Prof. R. O. Kapp, who opened the discussion, pointed out that a large and growing portion of the time of a scientific worker or engineer is now concerned with the written and spoken word, and the presentation of technical information is no longer of subordinate importance but dominates many of our activities. This is an inevitable consequence of the development of our delicately balanced civilization, which depends more and more on collaboration within an ever-widening circle. This collaboration, he said, can only be achieved with the help of an interchange of information, much of which is technical, and the written and spoken word have now become important tools with which scientific men and engineers have to work. From this point of view, Prof. Kapp developed his plea for more care and thought in the art of exposition, both to avoid the waste of time of the reader, and to avoid the possibility of misunderstanding or misinterpretation leading to wrong action. Equally, he observed, if a report is not adapted to its purpose, confusing or difficult to follow, ambiguous, or requiring excessive time for perusal, it may easily lead to the report being ignored, with the result that some desirable action is not taken. Reports, he insisted, are an essential part of the machinery of an organisation, and the efficient working of an organisation depends on their quality as much as it does on the quality of the tangible machines.

Prof. Kapp suggested that in our failure to appreciate the importance of the proper technique in the presentation of technical information, we have lapsed from early standards. The writings of eighteenth-century scientific men show many examples of good exposition, and it was only as the nineteenth century advanced that the increasing preoccupation of scientific men with their own specialized field made most of them tend to become less aware of other people. Prof. Kapp did not pursue the question whether the art of technical exposition could fairly claim to be recognized as an intellectual discipline; but he urged that we should at least study the technique in all its aspects and attempt to perfect and to teach it. Whether we are concerned with scientific books and papers to learned societies, with the spoken word such as the lecture, with the technical report, with that voluminous but valuable technical literature, often unjustly disparaged, which every manufacturer has to issue to ensure that his customers make proper use of his products, or with the spoken word in conference and committee, full regard must be had to the psychological factor if exposition is to be appropriate and effective.

This need for the good expositor to be vividly aware of other people was also illustrated by Prof. Kapp in reference to typography, and the choice of the most appropriate method for conveying technical information pictorially; but he pointed out that if illustrative material is not good, or if it is not used on a suitable occasion or on a suitable subject, it is ineffective, and by wasting time and diverting attention from the subject under discussion may even be misleading. While linguistics is the aspect of exposition most commonly referred to, Prof. Kapp believes that mastery of the English language is less important than either logic or awareness of the person addressed. The expositor who would express himself with precision must think clearly not only about the theme under discussion but also about the person to whom the information is being conveyed. The art of exposition demands more than anything else an understanding of the work done by the person to whom technical information is being presented.

This factor did not receive much discussion in the following papers, though it was well illustrated in Mr. L. Bainbridge-Bell's lively exposition of the need for clearer circuit diagrams. Those who were not electrical engineers followed his handling of a highly technical theme with obvious enjoyment and understanding, and his question to the visitor who remarked that it is nice sometimes to puzzle over a diagram, "When you ask your boss for a rise, do you put it in as an acrostic ?", well illustrates the practical character of his suggestions and principles for clearer presentation.

Miss M. D. Vernon's paper, giving a psychologist's view, said less than might have been expected about that aspect. It presented the results of an inquiry into the effectiveness of the use of graphical data, which emphasized the hiatus between the ability of the scientific worker and that of school children and the general public to understand numerical data presented to them in the form of diagrams, graphs or tables of figures. In general, Miss Vernon's inquiry suggested that the reader will not profit much from the inclusion of such data with a written text unless he or she has had sufficient training and experience in the use of such graphical forms, and that they must be simple and must not give information differing in any way from that presented in the text. Furthermore, the general argument or thesis must be clearly stated in the text, because the reader will be unlikely to work it out independently from the graphical and numerical data alone.

Miss Vernon's paper thus supported Prof. Kapp's plea for further study on the value of particular methods of illustrative material. Mr. Geoffrey Parr's paper on the relations between the technical author and his publisher was concerned in part with ways in which the average delay of four to six months in the publication of articles and fifteen to twenty months in the publication of books could be minimized by greater attention to details on the part of authors. In the average book of 80,000 words, the actual text or manuscript forms only 55–75 per cent of the whole book. Drawings and photographs may occupy 15–35 per cent, and preliminary matter, bibliographies, glossaries, and the index account for the remainder. The illustrations and the comparatively small remainder are the usual causes of delay in production, and Mr. Parr gave a check list of details liable to be overlooked which the author should verify as completed before submitting a manuscript.

Such a check list would include: all text pages numbered consecutively; figures and photographs numbered consecutively; suitable descriptions for each figure; permission to reproduce each borrowed figure; acknowledgments in preface; table of contents; list of plates (if not in text-matter); preface; foreword; bibliography checked and complete; references in text complete; references back in text made accurately; appendixes, if any; glossary; list of symbols (and examination of text to see that all symbols agree with list); and mathematics clearly set out. If all these are checked and complete, the delay in production caused by referring back to the author will be considerably lessened. Mr. Parr said that, in his experience, many of these items are regularly overlooked, and that among six hundred manuscripts read and checked during the past ten years, only five authors had submitted manuscripts in such a form that they could be sent to the printer without delay or query. He said that it is rare to receive a manuscript which does not involve lengthy correspondence and waiting time while the missing information is produced.

In the remaining paper, Mr. F. M. Colebrook dealt with the special features of the writing of scientific and technical papers which arise when the author is a member of the paid staff of a scientific organisation—more particularly of a national, or at least not a commercial, organisation. Mr. Colebrook drew mainly on his own experience in the National Physical Laboratory, and urged that the first distinctive feature is that the writing of papers by the staff of such organisations is, in general, a public duty, since such papers are sometimes the main return to the public for the public money spent. It followed that it is an obligation on the senior officers of such organisations to see that the papers are written, and are written well. The practical problem is very often to persuade the reluctant authors, but besides this it is necessary for the organisation to assist and advise its potential authors. This is bound up with the second distinctive feature, that the good name and reputation of the organisation as a whole are involved in the papers that are written by its individual members. Mr. Colebrook recognized that this gave the organisation the right, if not the obligation, to foster and insist on a high standard of presentation and also the right to control publication within certain limits. This he regarded as a proper and useful discipline rather than any real infringement of freedom of expression; but he thought that the balance of argument is heavily against anonymity, and that any departure from the principle that the names appearing on papers should be those of the real authors is a breach of professional ethics. Mr. Colebrook took the view that the reading of the paper in manuscript by one or more colleagues is an aid to the maintenance of high standards of presentation, and that organisations could also assist the early and effective dissemination of information.

Apart from these points, however, Mr. Colebrook's paper, like the other papers and contributions to the discussion, was stronger at diagnosis than in suggestions for action. Prof. Kapp, indeed, suggested that study of the factors on which receptivity depends, the laws which govern the association of ideas and the way memory works, would be useful, as well as the investigation of the criteria for distinguishing between good and bad methods of pictorial presentation; but no one went nearer to the root of the immediate trouble than the overseas student who pleaded that some systematic instruction in the presentation of reports and scientific papers should be given in the universities. With that and effective teaching of English usage and composition in the schools, there should be little need for a periodical on the subject or for further additions to a reasonably adequate literature, at least so far as the linguistic aspect is concerned.

NEWS and VIEWS

New South Wales University of Technology

DURING the past year, considerable attention has been paid to the encouragement and organisation of research work within the New South Wales University of Technology. Facilities for carrying out investigations have been established, including the appointment of research workers and technical officers with sufficient time free from teaching commitments to enable them to assist the professors and lecturing staff in designing equipment, in setting up apparatus, in carrying out tests and ensuring continuity of work. In addition to the generous Nuffield grant of £25,000 for the Nuffield research professorship in mechanical engineering, the work of the University has been given further tangible recognition by the Commonwealth Universities Commission, which has allocated £10,000 for carrying out research work in the University in 1950, and a similar amount for 1951. The Joint Coal Board has given £11,000 for research into mining problems. Projects being undertaken in the fields of applied chemistry and chemical engineering are prominent in the list, and in certain cases are being carried out in conjunction with the Commonwealth Scientific and Industrial Research Organization. The full range includes also mechanical, civil and electrical engineering projects.

Prof. R. M. Hartwell

Mr. R. M. Hartwell has been appointed to the foundation chair in the Faculty of the Humanities in the University; the title of the chair will be that of economic history. Mr. Hartwell is completing requirements for the degree of doctor of philosophy in the University of Oxford under a National University Fellowship, and he has also been elected to a fellowship of Nuffield College. Mr. Hartwell, who is twenty-nine years of age, was a foundation student of the Armidale University College and took his M.A. degree with first-class honours and the University medal in economics at the University of Sydney as a teaching fellow in the Faculty of Economics. He has carried out research on the economic history of both Australia and Tasmania, and on the development of the wool manufacturing trade of the British Commonwealth. He is at present visiting leading universities and technological institutions in Europe and in America. His present appointment at Sydney is in conformity with the policy adopted by the governing council of the New South Wales University of Technology of including the humanities as compulsory subjects in its degree courses from their inception.

Bicentenary of A. G. Werner (1750–1817)

ABRAHAM GOTTLOB WERNER, the eminent German geologist, came of a family long engaged in the mining industry, and was born at Wehrau in Saxony on September 25, 1750. He was educated at a school in Silesia and then was employed in a foundry under his father, who taught him to recognize the various minerals. At the age of eighteen, a visit to Freiburg led to his studying there and at Leipzig, and in 1774 he published his first paper, "The External Characteristic Features of Fossils". In 1775 he was appointed inspector of collections and teacher in the Mining School at Freiburg. His teaching was always fresh and vigorous, and in a few years Freiburg became the great centre for the study of mineralogy and structural geology. Werner published but little, and his widespread influence was due to the succession of eminent students who worked under him: among these were Humboldt, Brucchi, von Buch, Reuss, Brochant de Villiers, Giesecke, Hailstone, Greenhaugh, Freiesleben, Charpentier and many others. In 1787 Werner published a treatise on the classification of rocks, and in 1791 he wrote a work on his view of the formation of veins. The Wernerian doctrine taught "that all the rocks of the crust like the earth's body itself have taken origin from aqueous solutions, either as chemical or as mechanical precipitates, while volcanic lavas and scoriæ represented rock material that had been so precipitated but had subsequently been melted and ejected". The controversy between the Neptunists and Vulcanists waged for many years, especially in Germany, and much valuable time was lost in the discussions that followed. Werner was a born teacher; he possessed a marvellous memory and quick powers of observation, and he never relaxed his reading and research. He visited Paris in 1802 and was elected a foreign associate of the Academy of Sciences. After holding his post in the Mining School at Freiburg for more than forty years, Werner died at Dresden, unmarried, on June 30, 1817.

Chemistry and the Press: Panel of Expert Writers

THE Chemical Council, which represents the Royal Institute of Chemistry, the Chemical Society and the Society of Chemical Industry, has recently set up a panel of chemists who are qualified both as chemists and as writers, and also who are willing to undertake the writing of occasional articles for the weekly periodicals and magazines and the daily Press. In selecting this panel, due regard has been paid not only to the members' qualifications in chemistry, particularly in specified fields of work, but also to their ability to write for the non-scientific reader. The council of the Royal Institute of Chemistry has agreed to act as a centre for directing inquiries from editors to appropriate experts on the panel; but the Chemical Council insists that neither the contributors of articles nor the officers of the Royal Institute of Chemistry should be troubled by requests for information over the telephone or asked to supply quick answers to current inquiries, since this method involves risk of the information being incorrectly reported. The Council also considers that there should be some assurance from editors that the articles thus prepared will not be treated in a way that distorts the meaning or balance of the presentation, and it suggests that the scientific contributor should be given the assurance that he will see a proof of the article before publication so that he may have an opportunity of amending or rejecting. The panel has been drawn up mainly at the suggestion, and for the convenience, of representatives of the Press; but no claim is made that the list contains the names of all those qualified to write suitable articles for the lay Press, nor does the Chemical Council claim to be the sole source of information as to who is most competent to write such articles. As a general guide to editors, the list of writers is classified under six main headings: the science of chemistry; chemistry in agriculture; chemistry in relation to foods and nutrition; chemistry in relation to medicine; chemistry and the law; and chemistry in industry.

Dunlop Research Centre in Negri Sembilan, Malaya

AT a time of political stress in Malaya, it is a noteworthy achievement that the Dunlop Research Centre, situated in Negri Sembilan, on the Regent Estate of Dunlop Malayan Estates, Ltd., should have been opened last June. It is to be hoped that, with improving conditions, it will form a nucleus leading to considerable new knowledge and technical achievement in the East. The main building contains two large air-conditioned laboratories, an office, a store, an air-conditioning plant, a large workshop, and three good flats for senior Asiatic staff. In the immediate vicinity are bungalows which provide accommodation for the director of research (Dr. F. J. Paton) and the technical staff. Since Dunlop Malayan Estates, Ltd., devotes almost all the capacity of its 80,000 acres to the production of rubber latex, its problems are to a large extent physico-chemical and colloid in character, and considerable attention is being given to the study of latex constitution and to treatments in Malaya that will make the latex more and more suitable for home-manufacturing processes. New methods of latex preservation other than the usual ammonia preservation are being actively investigated. Centrifuging is the chief method employed for concentrating latex, although, more recently, interesting electrodecantation methods have received close attention. The Dunlop Estates carry a large proportion of clonal trees. Such trees give high yields, and their further development is a particular concern of the Research Centre, especially the relationship of latex quality, constitution and yield to the clonal strain. It is particularly opportune that the opening of the Research Centre in Malaya coincided with the opening of the Dunlop Research Centre in Birmingham (see *Nature*, July 8, p. 52). Many latex researches have necessarily to be carried out on the spot in the Far East; but the close liaison with the research staff in Great Britain and periodical interchange of staff afford a unique opportunity of correlating quality after shipment with initial treatment and of bringing consumer and producer problems into true technical perspective. The new Malayan Research Centre keeps in close touch with the Rubber Research Institute in Kuala Lumpur, and there is much friendly co-operation and rivalry with the technical groups of other producing companies in Malaya.

New Material on Benjamin Franklin

BESIDES the story of "Philosophical Hall" which has served as the home of the Society for 160 years, a recent issue of the *Proceedings of the American Philosophical Society* (94, No. 3; June 20, 1950) contains a considerable amount of hitherto unpublished information about Benjamin Franklin. Among the papers is one by Prof. Gilbert Chinard describing the Abbé Lefebure de la Roche's recollections of Franklin; this is accompanied by a photograph of a portrait of Franklin painted by an unknown artist and acquired by the American Philosophical Society from Paris a year ago. Prof. I. B. Cohen comments on the facsimile of a short pamphlet printed by Franklin to describe his observations on the transit of Mercury which occurred in 1753. Franklin's anticipation of modern psychological warfare is reported by Lynam H. Butterfield in an article which describes the successful plan adopted jointly by Jefferson and Franklin to cause desertions among the Hessian mercenaries who had been hired by George III to take part in the American Civil War. The way Franklin's fame and influence increased in Italy until it reached a peak in the last half of the nineteenth century is described by Prof. Antonio Pace, while Charles Coleman Sellers gives an illustrated account of the portraits of Franklin painted by C. W. Peak. Among other interesting articles in the *Proceedings* is a description of some American students of "that shining oracle of physic", Dr. William Cullen of Edinburgh, during the years 1755–66, and the story of the magnetic recording of American Indian languages.

Prehistory and the Humanities

THE study of prehistory can be a pleasing intellectual hobby, dealing as it does with the origins and early cultures of mankind. But, while this is perhaps its main contribution to the present age there is, too, another more philosophical side to the picture. A realization of the great age not only of humanity but also of seemingly advanced cultures and their rise and fall does affect one's outlook on life. Our own times, seen against this vast background of antiquity, take on a new importance, or rather lack of importance. It is well, sometimes, for esearch workers in the field to stand back and look at the implications of their work. Dr. C. van Riet Lowe is clearly doing this in his article entitled Prehistory and the Humanities" (*S. African J. Sci.*, 47, 3; 1950), and finding something very interesting. One result of his studies which has impressed him has been the fact of the unity of the human race and the importance of the teaching of prehistory for demonstrating this fact. Dr. Lowe feels that an appreciation of spiritual issues is vital nowadays in our crumbling world, and that the churches would do well to realize and utilize the results obtained by what is already a long period of prehistoric research.

Plant Viruses and Virus Diseases

IN the Masters Memorial Lectures of the Royal Horticultural Society for 1949, delivered by Dr. Kenneth M. Smith (*J. Roy. Hort. Soc.*, 74, Pts. 11 and 12; 1949), the whole subject of plant virus pathology is reviewed, and teachers will find them a very useful and well-illustrated summary of modern knowledge. With regard to the field of virus-insect relations, several new and useful points of view are expressed. Dr. Smith considers that the evidence for multiplication of the virus within an insect vector has not been, on the whole, very conclusive. He cites, however, the case of clover club-leaf virus, which retains infectivity over fifteen generations of its specific leaf-hopper vector. This would involve a dilution calculated at 10^{-17}. No known virus appears to be able to sustain such a high dilution, and this discovery is perhaps the best piece of evidence that a virus can multiply within its vector. It is also stated that, for non-persistent viruses, a short feeding time for an aphid of 3–5 minutes imparts maximum infectivity. Non-persistent viruses, indeed, seem to be carried only by aphids. Persistent viruses, on the other hand, may have leaf-hoppers, aphids and thrips as vectors.

New Displays at the British Museum (Natural History)

IN the July issue of the *Museums Journal*, Mr. J. P. Doncaster, who is in charge of the exhibition section at the British Museum (Natural History), describes some new displays of exhibits that have been installed recently. The classification of the vertebrates is the first subject dealt with, and here the aim is to present the basic facts required by the student of biology. To this end the existing wall-cases were stripped of internal fittings and replaced by sloping display boards. Fluorescent tubes provide internal lighting. In general, the exhibited material is on the lower boards, while the upper are used for charts and diagrams. A neutral-grey fabric is used as a background, and labels are of two types. General and explanatory labels are given prominence by being printed on cream paper, while the individual labels for the specimens are printed on a grey paper which tones with the background. Another exhibit, on virus diseases, is also described. In conclusion, Mr. Doncaster deals with the systematic type of exhibit, especially in relation to mammals and birds. This pioneer article will be found to be of especial interest to all those engaged in modern museum display.

Research Committee for the Gas Industry

THE Gas Council announces that it has set up a research committee consisting of Sir Edgar Sylvester (chairman of the Gas Council); Sir Robert Robinson and Sir Cyril Hinshelwood (as two men of science not engaged in the gas industry); Mr. E. Crowther, Dr. R. S. Edwards, and Mr. W. K. Hutchison (members of the Gas Council); Mr. F. M. Birks (president of the Institution of Gas Engineers); and Prof. A. L. Roberts (Livesey professor of coal gas and fuel industries in the University of Leeds). The laboratories of the North Thames Gas Board have been recognized as the nucleus of a London research station, and Dr. H. Hollings, who for some years has been controller of those laboratories, has joined the committee as director-designate of the station.

University of Glasgow: Fifth Centenary

THE University of Glasgow will celebrate its fifth centenary during June 1951. Representatives of universities, learned societies and public bodies and persons distinguished in academic and public life are being invited. The main ceremonial functions will be during June 19–21, culminating in a visit by the King and Queen on the last day. The meetings will include the presentation of addresses by delegates in the Bute Hall of the University, a commemoration service in the Cathedral, and meetings in St. Andrews Hall, including an honorary graduation. The Fifth Centenary Medal in bronze, 2½ in. diameter, is now being struck. Publications will include an illustrated brochure upon historical and contemporary aspects of the University; a volume of Fifth Centenary Lectures which will be delivered during the 1950–51 academic session; a history of the University; and "The Book of The Fifth Centenary", which will be the official record of the occasion. The arrangements are in the hands of the University of Glasgow Fifth Centenary Committee, Glasgow, W.2, the secretary of which is Mr. J. B. Neilson.

Fourth Congress of the International Scientific Film Association

THE fourth Congress of the International Scientific Film Association will be held in Florence during October 14–22. As in the case of the three previous Congresses held in Paris, London and Brussels, there will be a festival of scientific films, as well as specialist group meetings of the Medical, Research Film and Industrial Film Committees, and also the business meetings of the general assembly of the Congress. A special committee of the British Scientific Film Association has been formed to recommend films for submission to the festival, and prospective exhibitors should, as soon as possible, send to the Association full details about their films, including running-time, gauge, date of production, brief synopsis, etc. The address of the British Scientific Film Association is 4 Great Russell Street, London, W.C.1.

U.S. National Academy of Sciences: Autumn Meeting

THE autumn meeting of the U.S. National Academy of Sciences will be held at the Research Laboratory, General Electric Co., Schenectady, New York, during October 9–12. On the afternoon of October 9 the new buildings of the Research Laboratory will be dedicated, and C. E. Wilson, president of the General Electric Co., will be the principal speaker. On the evening of October 10 Dr. C. P. Rhoads, director of the Sloan–Kettering Institute for Cancer Research, will deliver a public lecture in the Memorial Chapel, Union College. The Academy dinner for members, guests and members of the Capitol District Sections of Technical Societies will be held on October 11, and Sir Lawrence Bragg, Cavendish professor of experimental physics in the University of Cambridge, will be the principal speaker.

Announcements

A MEMORIAL window to the late Sir Charles Parsons will be unveiled in Westminster Abbey on October 5 by Sir Robert Robinson, president of the Royal Society. The window will be dedicated by the Dean of Westminster, and a memorial oration will be delivered by Sir Frank Smith.

THE Council of the British Coal Utilisation Research Association has appointed Mr. R. L. Brown to succeed the late Dr. D. H. Bangham as director of research laboratories. Mr. Brown joined the staff of the Association in 1938, having earlier taken first-class honours in the Mathematical Tripos at Cambridge.

MR. J. S. SHEPPARD has been appointed to the University readership in mine surveying tenable at the Imperial College of Science and Technology, London.

THE Edward Teshmaker Busk studentship of £300 a year for research in experimental and mathematical aeronautics carried out in Great Britain or abroad has been awarded for the year 1950–51 to Robert Westley, of the College of Aeronautics, Cranfield.

THE Institute of Biology, which held its first general meeting in King's College, London, on January 5 (see *Nature*, 165, 131; 1950), has now obtained office premises at 17*a* Onslow Gardens, London, S.W.7, telephone number Kensington 4882–3. Mr. A. Fielding Clarke has been appointed general secretary. All communications should be addressed to the general secretary, who will be glad to supply further information to prospective members.

THE Physical Society will hold a symposium on cosmic rays on September 29, and on November 24 a number of papers will be given on various aspects of electrical discharge. On December 8 the autumn provincial meeting of the Society will be held at Cambridge, when Sir James Chadwick will deliver the Rutherford Lecture. Further details of these meetings can be obtained from the Secretary, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

THE twenty-first annual conference of the National Smoke Abatement Society will be held at Margate during September 27–29. The Conference will be marked by the presentation of the first Des Voeux Memorial Lecture, established in honour of the Society's first president, Dr. H. A. Des Voeux, who helped to found one of its two parent bodies in London in 1899. It will be delivered by Dr. D. T. A. Townend, director-general of the British Coal Utilisation Research Association. Further particulars of the Conference can be obtained from the general secretary of the Association, Chandos House, Buckingham Gate, London, S.W.1.

THE twelfth National Conference for the Preservation of the Countryside, organised by the Council for the Preservation of Rural England, will be held at Tunbridge Wells during October 19–22. The theme this year will be "Modern Developments in Rural England", and three sessions on, respectively, the impact of industry on rural life, problems of rural electrification, and planning and afforestation, will be held in the Assembly Hall, Tunbridge Wells. The headquarters of the Conference will be at the Spa Hotel, where there will be an inquiry office. Further details can be obtained from the Secretary, C.P.R.E., 4 Hobart Place, London, S.W.1.

CONCEALED COALFIELDS OF THE MIDLANDS

SINGULARLY appropriate to the presidential theme of "Man's Use of Energy", and also to the Birmingham setting of the British Association meeting, was the discussion held by Section C on the subject of "The Concealed Coalfields of the Midlands". This discussion followed naturally the accounts of the work of Charles Lapworth which had been delivered on the previous day.

Prof. L. J. Wills, in opening his address, paid tribute to Lapworth's report on the Midlands, made to the Coal Commission of 1905; but explained that since that time so much new information has been acquired that it is necessary to analyse afresh the geological factors determining the distribution of Coal Measures throughout the area. Nearly all the valuable coals, Prof. Wills pointed out, are contained in the productive coal measures below the Aegir (Mansfield) Marine Band, and zoning has shown that this coal-belt thins towards the south due to non-deposition of sediments. Shortly after these coals were laid down, there followed, in the early stages of the Upper Coal Measures, the first Malvernian folding and erosion, which removed the coals from a large area in Shropshire. Prof. Wills also believes that it was at this time, and not later, that much of the erosion took place in the Pennine anticline and in Charnwood. Afterwards, the second Malvernian folding, at the end of the Keele–Enville period, produced sharp anticlines and reversed faults in certain narrow belts. In Enville times, sedimentation was confined to the down-warps, but little erosion took place from the up-warps except in a region south of Birmingham, where the 'Mercian Uplands' had begun to rise. The period that followed was one of vertical block-movements with the establishment of well-defined horsts and graben. During the Clent Breccia and Bridgnorth Dune Sandstone stages the horsts were being denuded at the same time as sedimentation took place in the graben. Later, the area of deposition extended during the Bunter Pebble Beds and Keuper and a great levelling-up took place. Further vertical displacements of the fault blocks were brought about by post-Triassic movements, and subsequent denudation of the resultant horsts has exposed the five Midland coalfields. In the intervening areas the cover of New Red rocks is extremely variable, both in nature and thickness.

Prof. Wills illustrated his thesis by a comprehensive series of maps in which each stage in the development processes was demonstrated. The results of his analysis were summarized in a final map showing his conclusions regarding the extent of the present hidden coalfields and the probable depths of cover.

Dr. G. M. Lees then presented an account of geological deductions from geophysical work by the Anglo-Iranian Oil Co., Ltd., bearing on the prospect of Coal Measures in the South Midlands area. In his opening remarks, he explained that his interest in the extent of Coal Measures was incidental to the search for oil, and arose because the conditions under which oil had been found in carboniferous rocks of the East Midlands monocline had encouraged a search for further areas in which similar structures might retain a considerable cover of Coal Measures. An analysis of the main structural trends which had affected southern England, particularly when considered in relation to the structure of northern France and the lowlands of Europe, led him to believe possible a wide extent of concealed Coal Measures. Dr. Lees pointed out that over much of southern England the average density of boreholes which have proved Palæozoic rocks is only one in approximately 600 square miles, and the Anglo-Iranian Oil Co. had therefore set out to gain further information from geophysical work. Lantern slides were shown giving contour maps of Bouguer gravity anomaly summarizing the results of the gravimeter surveys. These surveys revealed, in a number of areas, gravity lows, which persisted as areas of low gravity after allowance was made for the effects of known and estimated thicknesses of Mesozoic cover. Extensions of the gravimetric observations revealed gravity lows in close association with the coal basins of the Kent and Bristol coalfields, and on the basis of these associations the gravity lows in a belt south of Worcester and in areas near Oxford, near Redhill, and in the Thames estuary were regarded as indicating the presence of further Coal Measure basins.

In certain areas the gravimetric surveys had been followed up by seismic work, and a high-velocity medium, interpreted as the Carboniferous Limestone, had been followed at depths of the order of 6,000 ft. Though the methods employed could not differentiate between Upper Carboniferous and Triassic rocks, nevertheless, since in these areas a great thickness of Trias was unlikely, the seismic results therefore appeared to support the conclusions reached from interpretation of the gravimetric measurements. Some geophysical work is still in progress and it is desirable that the survey should be supported by suitable boreholes. In conclusion, Dr. Lees expressed the view that investigations of this nature could play a part in the exploration for further coal resources.

Mr. T. Eastwood, who followed, said that for some years his attention had been turned to the possibility of potential coal resources in the area between the South Staffordshire and Warwickshire coalfields. Basically, he had approached the problem by asking three questions: first, has any coal ever been there?; then, if so, how much was there originally?; and finally, how much now remains? Similarities in the coal sequences of Warwickshire and south Staffordshire suggest that they were deposited in a single Coal Measure basin, and that similar deposition must have taken place in the area between the two coalfields. The present arrangement of Keele and Etruria outcrops in the Warwickshire coalfield shows that the dominant structure is a syncline pitching southwards. In the South Staffordshire coalfield, although the most northerly beds show a westerly dip, the main structure is also a syncline pitching south, and consideration of conditions at the margins of the exposed coalfields suggests that this structure is again repeated in the area between the two coalfields. A complicating factor, however, is the presence of the Hints Fault, which might have a considerable downthrow to the south-east. Outcrops of lower beds of the Trias near Lichfield appear to reflect an anticline crossing the inter-coalfield syncline, and in 1949 a Geological Survey boring was drilled on this anticline north-west of the

Hints Fault. In this boring were proved 30 ft. of workable coals at depths of less than 3,000 ft. The succession encountered can be correlated closely with that of the Cannock area, thus suggesting the existence of a considerable concealed coalfield extending from the north-eastern margin of the South Staffordshire coalfield into the Lichfield area.

Prof. W. G. Fearnsides next gave some details of explorations carried out in the West Midlands by the National Coal Board during the past few years. He dealt first with the area to the north-east of Cannock Chase where, about two years ago, a boring programme was started in the hope of reinforcing the dwindling resources of Brereton Colliery, south-east of Rugeley. Almost at the same time as the Survey boring at Whittington, the first boring outside the eastern boundary fault was drilled at Redhill. This entered the Coal Measures at considerably less than 1,000 ft., afterwards proving the full Cannock succession of coals. Further borings to the north and north-east all proved the workable coals, which appear to lie in a shelf at least two miles wide and thrown down about 1,000 ft. from those of the exposed coalfield. In this area the quality of the coals is good, and seam gradients, indicated by the boreholes, extremely low. Prof. Fearnsides went on to describe the explorations by which new resources have also been proved east of the Coalbrookdale coalfield in areas north-east of Lilleshall and in the Madeley syncline. Further explorations are being made in several areas west and east of the South Staffordshire coalfield and south of the Warwickshire coalfield. Up to the present, from twenty deep borings in the West Midlands, considerable new resources have been proved.

The final speaker, Dr. G. H. Mitchell, dealt with the area east of the Warwickshire coalfield, and summarized information which has recently been made available from operations in that area by the National Coal Board and the Directorate of Opencast Coal Production. Recently, the limits of the South Derbyshire–Leicestershire coalfield have been proved to run from Desford, through Nailstone, Heather and Snarestone, to Netherseal. North-east of Netherseal the coals lie in a roughly basin-like structure, interrupted by many local contortions and faults. The basin is broken on the west by large faults beyond which the Coal Measures have not yet been proved. On the east side of the coalfield the Thringstone Fault is now known to be a large reversed fault. Between the South Derbyshire–Leicester coalfield and the Warwickshire coalfield, borings at Market Bosworth have proved Cambrian strata. The eastern extension of the Warwickshire coalfield is still unproved.

In the open discussion which followed, Mr. W. Bullerwell displayed maps showing some results of a gravimetric survey made by the Geological Survey over an area connecting the Coalbrookdale coalfield and the northern parts of the South Staffordshire and Warwickshire coalfields.

Dr. C. J. Stubblefield stated that the southern coalfields of the Midlands appear to be faunally connected with a province south of the Brabant Massif, and that certain differences between their marine faunal assemblages and those of the South Derbyshire coalfield suggest that in Coal Measure times a barrier may have existed between the coalfields of Warwickshire and South Derbyshire. Supplementing Mr. Eastwood's remarks on the Whittington boring, Dr. Stubblefield added that the lower section has proved fossiliferous Millstone Grit, Carboniferous Limestone of northern facies, and—a rarity in the Midlands—fossiliferous Upper Old Red Sandstone.

Dr. P. E. Kent said that from the investigations east of Charnwood by the Anglo-Iranian Oil Co., it appears possible that a deep syncline containing Coal Measures exists near Grantham. Coal Measures may also be present in the Melton Mowbray area in troughs adjacent to the boring at Sproxton which, drilled on an anticline, has proved Millstone Grit.

Prof. L. R. Moore outlined similarities between beds which were deposited about the time of Malvernoid movements in the South Wales–Bristol district and corresponding sections in the Midlands which had been described by Prof. Wills.

The large and representative audience was a clear indication that the meeting had aroused wide interest. From the particular point of view of a geophysicist, the proceedings demonstrated forcibly the absolute indispensability of the classical methods of pure deductive geology in the search for new coal resources, and also afforded a clear statement of the many questions which geophysical techniques must be able to answer before they can be considered to have graduated in coal measure problems. While present geophysical methods may assist greatly in the reconnaissance for new coalfields, the geologist and mining engineer require extremely detailed information before seam correlation, gradients and quality can be established firmly enough to support constructive planning. Only in exceptional circumstances can current geophysical methods give sufficiently accurate information at this stage, and there is therefore a need for further application and refinement. In view of this, it seems appropriate to conclude by expressing good wishes to the Department of Geophysics newly established under the Department of Geology at the University of Birmingham. In the light of the discussion, this new Department is not likely to be short of problems close at hand.

EXPERIMENTAL WORK WITH ATOMIC PILES

At the Birmingham meeting of the British Association, four papers were presented in a discussion arranged by Section A (Mathematics and Physics) on "The Application of Atomic Piles to Experiments in Nuclear Physics". The experiments related to the properties of the neutron itself, the properties of atomic nuclei and the application of the atomic pile to the study of solids.

Dr. R. E. Bell, of the Chalk River Laboratory, Canada, described an outstanding piece of experimentation in which Robson has measured the energy spectrum of the beta-rays emitted by the natural radioactive decay of a strong beam of neutrons, and has identified the protons produced. He has verified in detail the predictions about the radioactive properties of the neutron. Bell and Elliott have redetermined the binding energy of the deuteron by studying the capture gamma-rays from hydrogen. The new value obtained for the binding energy is considerably larger than the previously accepted value, so that the accepted mass of the neutron has to be raised by about forty parts in a million.

The energy-levels of nuclei have been studied by Kinsey, Bartholomew and Walker, who measured the spectra of capture gamma-rays emitted by a large selection of elements throughout the periodic table. They measured the energy of electron-positron pairs produced by the gamma-rays. The spectra become more and more complex as the capturing material is made heavier. Lead and bismuth, however, have simple spectra. The reasons for this behaviour are at present unknown.

The neutron cross-sections of nuclei have been studied at the Argonne Laboratory, Illinois, using three different methods. Dr. D. R. Inglis described the different methods used to select neutrons of a single energy. Narrow slits in a high-speed rotor chop neutron beams emerging from slits in a similar stator into short bursts. The reflexion of a light beam by the rotor on to a photo-cell triggers a multichannel counting system which selects neutrons by their time of flight. The small area of cross-section of the neutron beam between rotor and stator makes possible the study of small samples of separated isotopes which are inadequate for the pulsed cyclotron technique. Nuclear cross-sections at a definite neutron energy can also be studied using resonance scattering of a beam of neutrons from the pile. The sharp scattering resonance of xenon has been used to determine the absorption cross-section of boron at this energy. For higher energies the pile cannot be used to provide a source of monochromatized neutrons. Neutrons with energies between 5 keV. and 1 MeV. can be produced by bombarding lithium with protons, using very careful voltage regulation of the electrostatic accelerator. This is necessary because the reaction threshold is 1·88 MeV.

Beams of monochromatized pile neutrons can also be used for reinforcing the older technique of X-ray diffraction in the study of solids. Mr. G. E. Bacon, of the Atomic Energy Research Establishment, Harwell, described a double-crystal neutron spectrometer in use at Harwell. The first crystal, a few inches square, is used as a monochromator to select neutrons with wave-lengths lying within a narrow band from a collimated beam emerging from the thermal column of the pile. The neutrons diffracted from a second crystal are detected by a counter mounted on a rotating arm.

A comparison of the intensities of lines in the X-ray and neutron diffraction spectra of graphite confirms that anomalies in the X-ray intensities are due to the anisotropic distribution of electrons in each atom and not to any peculiarities of crystal structure. The neutrons scattered by the atomic nuclei show no anomaly.

Whereas the scattering of X-rays increases rapidly with atomic number, the scattering of neutrons is about the same for all elements. Neutron diffraction has therefore the advantage that light elements can be detected in the presence of heavy ones.

The fast neutrons in a pile can cause interesting changes in the physical properties of solids. Mr. T. M. Fry, of the Atomic Energy Research Establishment, Harwell, referred to the experiments of Lark-Horovitz, which demonstrated the production of electron-traps in germanium irradiated in the Oak Ridge pile. Siegel found that samples of Cu_3Au were disordered after prolonged irradiation at Oak Ridge. Dugdale at Harwell, on the other hand, has found that the resistivity of annealed samples of Cu_3Au falls as a result of short irradiations in the pile. This suggests that the degree of order of these samples is increased by the bombardment.

Berman, at the Clarendon Laboratory, Oxford, has observed that the thermal conductivity of a quartz crystal is reduced by successive irradiations at Harwell until its behaviour is more nearly that of a glass. These changes can be attributed to the scattering of thermal waves by clusters of interstitial atoms and vacant lattice points.

Experiments of this type should throw light on the structure-sensitive properties of solids.

T. M. Fry

MANAGEMENT BEHAVIOUR AND FOREMAN ATTITUDE

In a large-scale business enterprise there are many levels of administrative work. The administrator has responsibility for the process of blending productively the economic, technical and business requirements of complex situations. Some of the most perplexing human relations problems in industry, however, are faced by foremen, supervisors, and others in middle management groups, and to observe at first hand some of these problems of human relationships, Messrs. D. R. Ulrich, D. R. Booz and P. R. Lawrence, of the Graduate School of Business Administration, Harvard University, recently spent eight months in a factory in the United States.*

The particular plant chosen for study reflected many of the tensions and instabilities of an intensely competitive industry. It was one of many plants operated by a company with headquarters in New York. The products of the department were four models of a small, delicate instrument which had been invented and produced for only about two years. A great many technical engineering aspects in the production of this instrument were causing trouble continually.

A new general manager had called upon his immediate associates to operate as a management team. These men, all specialists in their fields, met at the manager's call to make or review all decisions concerning the plant.

Between the management team and the direct labour operators was a thin bridge of supervisors, foremen and staff specialists. At the work bench the company employed a large number of semi-skilled workers. These operators worked on production lines that were continually being revised according to the dictates of the engineering department as interpreted by the foremen.

Preoccupied with the demands made upon them by the hourly employees and the staff specialists, the supervisory personnel felt they did not themselves have adequate capacity to deal with these demands. Yet their efforts to get the help they needed from general management were not successful; instead, 'management' made the strongest demands of all.

The research group felt that a close knowledge of the personnel at each level would be necessary to understand the reasons for the gap between general management and other personnel. The team therefore spent about half its time in the plant talking with, and observing the activities of, thirty-six women who were hourly-paid employees in one department.

Although none of the women ever stated their problems in these words, it seemed to the observers that the only way the women felt they could make their factory life interesting and meaningful was through conversation with one another and through the development of informal groups. The frequent changes in the department kept disrupting these activities, and the women developed feelings of insecurity which manifested themselves primarily in an attitude of hostility toward management, an attitude which even the women themselves did not quite understand.

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* Management Behavior and Foreman Attitude: a Case Study. By David N. Ulrich, Donald R. Booz and Paul R. Lawrence. Pp. vii+56. (Boston, Mass.: Graduate School of Business Administration, Harvard University, 1950.) 75 cents.

The foreman of the department formed the main link between the higher members of management and the hourly employees. Since a distinct gap existed between management and the employees, since these groups frequently misunderstood each other, and since each tried to exert various kinds of pressure on the other, the position of the foreman was at once critically important and critically difficult. Caught squarely between these opposing pressures, he faced daily confusion, doubt and conflict in trying to reconcile them.

The employees viewed the foreman as an instrument of management. But what, in fact, were the foreman's relation with management ?

In the foreman's opinion, the superintendent entered the department only to criticize such matters as the way the floor had been swept. The foreman wished to see as little as possible of the superintendent and to receive as few instructions from him as possible. Critically significant to the foreman was the fact that he and his immediate supervisor were held solely responsible for the correlation of all requirements set up by staff personnel as well as 'line' superiors.

Missing from the situation was an effective method for translating special technical knowledge into terms that would be useful to the line personnel, and for translating line problems into terms that would have meaning to the specialists. The barrier that prevented this give-and-take from occurring was not in any sense a technical barrier but rather one of hostile attitudes between groups competing for greater control of the work.

The report indicates that the management of the company held in its own hands the key to many of the most critical human relationships in the plant; and that the turning of this key depended upon management's own behaviour. Yet rather than try to understand how the employees viewed management, management was preoccupied with trying to get employees to "understand things our way".

In these circumstances, it seemed imperative to the research group that management should stop worrying about getting its own message across to the employees and concentrate on finding out what the employees were trying in various ways to tell management. Only by so doing could management effectively narrow the gap existing between itself and the employees, including those at the supervisory level.

A characteristic of the pattern observed by the investigators was the self-perpetuating nature of the gap in communication between senior management and subordinate levels of the organisation. They concluded that a first step in bridging this gap would be for senior management to see more clearly what its own role in maintaining the gap had been.

In closing, the authors of this report stated that the most promising development in the company was the effort the general manager was making to increase his own understanding of the human factors in his administrative work. His efforts held the most significant kind of promise for the future.

T. H. HAWKINS

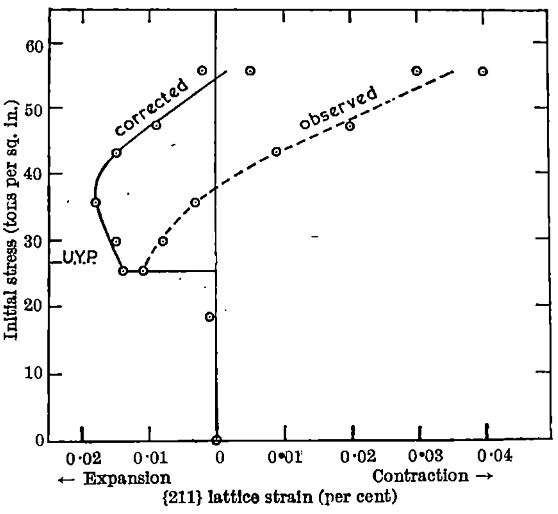
RESIDUAL STRAINS IN PLASTICALLY DEFORMED MILD STEELS

USING an accurate back-reflexion X-ray technique, residual strains in plastically deformed low-carbon steels (0·06–0·15 per cent C, 0·27–0·67 per cent Mn) were evaluated from the values of lattice spacings of planes lying parallel to the surface of previously extended plate-tensile specimens. The diffusion of the $K\alpha$ doublet, accompanying plastic deformation of the specimens, affected the photometrically measured diameter of the diffraction rings, introducing a fictitious lattice contraction. A correction for this deviation was applied by a method described previously[1]. The accompanying graph shows measured and corrected lattice strains for the {211} planes of a typical sample.

All specimens were ground from larger stock materials. Preliminary heat treatment *in vacuo* or in an inert atmosphere appeared to give consistent results, and the use of different mild surface etchants seemed without effect. No significant initial preferred orientation was detected in any specimen.

Axiality of loading was found to be of extreme importance, and the recording of a very clearly defined upper yield point was adopted as a criterion for axiality[2]. After unloading from within the mechanically determined elastic range, no residual strain of the type observed by Garrod[3] was detected. Pre-yield residual strain was confined entirely to specimens in which the initial loading was sufficiently eccentric to cause the suppression of the upper yield point.

In the large tensile specimens (0·1 in. × 0·5 in. cross-section) used in this investigation, the onset of plastic deformation was marked by the formation of a Lüder line, and yielding resulted in the creation of an inconsistent body strain with superimposed Heyn strains. This inconsistency, it is suggested, may be attributed to the heterogeneous plastic deformation within the confines of the Lüder line[4] and to the state of non-axial loading introduced by its presence, which results in a body or 'layer' strain peculiar to the geometry of the particular band of plastically deformed material. Residual strain was, at this stage, confined within the boundaries of the Lüder



line, and no support could be given to the observation by Cowley and Paterson[5] of diffuse spots on stationary diffraction photographs of the material adjacent to the line.

Throughout the range in which the specimen exhibited 'uniform' external plastic strain, the lattice strain appeared to be a simple function of the initial stress and characteristic for each set of crystallographic planes. These results agreed, in order of relative magnitude, with those obtained by Greenough on wire specimens[6]. Discontinuous yielding, however, associated with the comparatively large rectangular specimens, resulted in a shift of all the individual Heyn strains in accordance with the inconsistent body strain, and an approach to consistency could only be obtained by adopting the post-yield residual strain as an arbitrary zero for subsequent strain increments (see graph). Reduction to an arbitrary strain of $+1 \times 10^{-5}$, for the {211} spacing, gave the following strain relationship after a plastic deformation of approximately 19 per cent :

Lattice planes	{310}	{211}	{220}
Strain × 10^5	+20	+1	−24

After exceeding the nominal maximum stress, plastic flow became localized with the formation of a neck. All lattice planes tended towards residual contraction as necking proceeded (see graph). This suggested the development of a further body strain, which increased in magnitude with increasing severity of necking. The formation of this strain is consistent with the constrained recovery of the specimen as a whole from a duplex deformation mechanism, the core of the specimen having been subjected to an increasing triaxial tensile stress system while the surface has remained free to become deformed by shearing. To account for a body strain of the observed sign, it is necessary to postulate a relatively increased elastic range for the metal within the internal zone of triaxial stress. Such an assumption appears reasonable on theoretical grounds (cf. similar mechanism proposed by Greenough for residual lattice strains in plastically deformed copper and aluminium specimens[7]).

Body strains would be expected to depend on the size of the specimen (assuming an approximately constant crystallite size). A significant reduction in magnitude of the assumed body-strain component was, in fact, observed with a small tensile specimen (ground and lapped to 0·02 in. × 0·15 in. cross-section).

When comparing the behaviour of the ferrite matrices in analytically similar steels showing spheroidal carbide and ferrite–pearlite structures, respectively, the corrected systematic lattice strain curves were found to be similar provided that the steel was initially in a reasonably strain-free condition. There was, however, one significant difference observed between the two samples : at constant plastic strain, the breadth of the diffraction lines (measured conveniently as the α_1–α_2 doublet half-height width) was greater for the sample showing spheroidal carbide. A ready explanation for this observation can probably be given in terms of textural strain, which is greater for the sample with spheroidal carbide simply because there is an even distribution of small carbide particles in all ferrite grains, whereas in the other sample a majority of grains are pure ferrite, free from all disturbing carbide inclusions.

Summing up, in low-carbon steel the systematic residual strain in the ferrite matrix is confined to the plastic region and appears to be determined primarily by its inherent anisotropic characteristics and by the geometry of the test specimen.

I wish to express my appreciation of the interest taken in this investigation by Prof. J. H. Andrew, and to thank the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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April 27.

[1] Finch, L. G., *Nature*, **163**, 402 (1949).

[2] Warren, A. G., Inst. Met. Symposium, 209 (1947).

[3] Garrod, R. I., *Nature*, **165**, 241 (1950).

[4] Winlock, J., and Leiter, R. W. E., "The Working of Metals", 163 (Amer. Soc. for Metals, 1936).

[5] Cowley, J. M., and Paterson, M. S., *Nature*, **159**, 846 (1947).

[6] Greenough, G. B., *Metal Treatment*, **16**, 58 (1949).

[7] Greenough, G. B., *Proc. Roy. Soc.*, A, **197**, 556 (1949).

In an earlier communication[1] values were quoted for the residual lattice strains in iron after a plastic extension. More recent work has shown that, although the relative values were correct, their absolute magnitudes were in error. The error in the early work arose because the material used for the experiments was not, in fact, iron, but a mild steel which also contained small percentages of alloying elements. The annealing treatment given to the wires after plastic deformation not only removed the residual lattice strains, but also caused some metallurgical change which led to an increase in the unstrained lattice parameter. This latter change in lattice spacing was included in the residual lattice strain quoted, and consequently the values were all about 6×10^{-5} too small (algebraically).

In order to confirm that the correction applied to earlier results led to accurate values, the residual lattice strains have been measured in plastically extended wires of a mild steel (C = 0·10 per cent, Mn = 0·36 per cent, Si = 0·017 per cent, P = 0·007 per cent) which was free from variations in annealed parameter. Two series of results were obtained corresponding to two amounts of plastic extension, and these are shown in the accompanying table (cols. Nos. 2 and 3), together with the corrected values of the earlier results (1).

Plane reflecting	Residual lattice strains		
	Earlier results (corrected) 1	Confirmatory results 2	3
	$\times 10^{-5}$	$\times 10^{-5}$	$\times 10^{-5}$
310	+24	+30	+22
211	+7	+11	+9
110	−25	−6	−2
True stress previously applied (lb./sq. in. $\times 10^{-4}$)	7·3	5·3	4·2
Plastic extension (per cent)	19	15	10

If these values are plotted as before against the orientation function φ, the derivation of which has been described elsewhere[2], the gradients of the three straight lines obtained are approximately proportional to the stress applied to the aggregate. This is in accord with the quantitative interpretation of the Heyn intergranular stress explanation previously adopted. On the other hand, the average residual lattice strain (which is equivalent to the intersection of the graph with the residual lattice strain axis) is markedly positive, and not zero as the Heyn stress theory anticipates. Thus mild steel shows the same type of compressive macroscopic stress superimposed on the Heyn stresses as has been discussed elsewhere[2]. In this discussion it was shown to be probable that a compressive stress is likely to arise in the surface layers of an aggregate because grains with a free surface would be softer than those of the same orientation in the interior of the aggregate. Experimental work which is just being concluded has shown that the surface layers of a plastically extended specimen do contain macroscopic compressive stresses, and if these are removed the mean of the observed residual lattice strains becomes much more nearly zero.

This surface compressive layer could be regarded as a particular case of the body strains arising from discontinuous yielding, to which Finch[3] attributes his anomalous results; but it seems unlikely that the geometry of the specimen would much influence the surface stress layer unless the specimen size were made of the same order as the grain size of the aggregate.

Recently, Garrod[4] has said that the explanation of residual lattice strains based on Heyn stresses "involves the assumption that, in a randomly orientated polycrystalline aggregate deforming under, for example, a tensile stress, some grains, in which the glide planes and glide directions are suitably orientated with respect to the stress direction, will yield *before* their neighbours". That some grains must undergo appreciable plastic strain before others yield is a misconception, and may have resulted from insufficient clarity of expression in my earlier papers. In these, the term 'yield tension' of any grain has been used for describing the tensile stress required to cause further plastic flow in that grain, and not the stress required to initiate plastic deformation in the annealed crystal. It was always supposed that if the plastic extension of an aggregate was appreciable, say greater than 0·5 per cent, then slip must have occurred in *all* the grains. This was because the elastic limit of even the hardest grain does not exceed 0·2 per cent, and it appeared unlikely that contact would be maintained between the various grains in an aggregate during a plastic extension of 0·5 per cent if the strains in some grains were less than 0·2 per cent. The whole of the quantitative treatment was based on this assumption. The particular experimental observation by Garrod that grains of all orientations start to become deformed plastically at about the same macroscopic strain value is thus in accord with the general basis of the explanation of residual lattice strains in terms of Heyn stresses.

However, the residual lattice strains observed by Garrod, by Finch and by myself in mild steel specimens after the application and removal of tensile stresses exceeding the macroscopic yield stress of the aggregate, all confirm the view that, whereas Heyn intergranular stresses make a considerable contribution to the observed residual lattice strains, other stress systems must also be present.

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[1] Greenough, G. B., *Nature*, **160**, 258 (1947).

[2] Greenough, G. B., *Proc. Roy. Soc.*, A, **197**, 556 (1949).

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HABITS AND LIFE-CYCLE OF *CULICOIDES NUBECULOSUS* MG.

By J. A. DOWNES

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OBSERVATIONS on the blood-sucking midge *Culicoides nubeculosus* Mg. (Diptera: Ceratopogonidæ) have been made in Nature at Chideock, Dorset, and in the laboratory. The results provide some interesting comparisons with recent work on mosquitoes and other Nematocera.

Around Chideock, *C. nubeculosus* inhabits farmyards. The larvæ live in hoof-print puddles heavily contaminated with the excreta of cattle, and the adults rarely stray as much as a hundred yards from the larval habitat. The natural food of the adults of this strain is unknown; they do not bite man in Nature, although they will do so readily in the laboratory. Elsewhere, the species is known to feed on man and on horses. All observations indicate, however, that a blood meal is essential for the development of the eggs.

Male swarms. Around and after sunset, and again after sunrise, small discrete swarms (less than a hundred individuals) of the midge were observed along a light-coloured sandy road running through a farmyard. The swarm consisted of males only, performing a very characteristic side-to-side dancing flight with occasional vertical excursions. The swarms were columnar and extended from 2 ft. to about 8 ft. above the ground. In the swarm, the midges all faced towards the slight wind, from whatever direction it was blowing (a stronger wind inhibits flight); and the swarm as a whole remained stationary directly above a well-defined object. Natural 'swarm-markers' included pads of cow-dung and patches of dark mud, wet or dry, lying on the paler road; similarly, swarms could be produced at will by laying down a 20–100-cm. sq. black cloth. The first midge to arrive over such a cloth immediately starts to perform the characteristic swarming dance and will continue for perhaps several minutes, until others arrive and a typical swarm is built up.

These observations show that swarming depends on the visual responses of the midge to a 'swarm-marker', in this case a dark object of appropriate size, which viewed from moving air appears to be travelling forward. Similar responses have been demonstrated in unfed females of *Aëdes ægypti*[1]. Since each insect is responding independently to the common 'marker', and there may in the limit be only one present, it is not, on the first analysis at least, a true gregarious phenomenon. 'Swarms' consisting of single insects have been observed also in *Aëdes cantans*[2].

Mating. Gibson[3] has shown that, in *Spaniotoma minima* (Chironomidæ), males and females both take part in the swarming dance. Eventually mating occurs, the pair fall to the ground, and the fertilized females do not rejoin the swarm. Thus in any well-established swarm, females are in a considerable minority. In *C. nubeculosus* (and six other species of *Culicoides*) all swarms examined consisted entirely of males. Nevertheless, midges *in copula* have twice been found on the 'swarm-markers'. Presumably females sometimes enter the swarm, and when this happens mating takes place almost instantaneously. Probably, however, the swarm is not the only, or even an important, occasion of mating, since in captivity pairing occurs readily in 3 in. × 1 in. glass tubes, in which flight is severely restricted (compare the case of *Anopheles maculipennis* var. *atroparvus*[4]). Moreover, males will mate with the completely immobile females actually engaged in biting, as already noticed by Pomerantzev[5]. All three types of mating last some two to three minutes and result in successful transfer of sperm to the spermatheca of the female.

Roth[6] found that the mating reflex of *Aëdes œgypti* is elicited by the characteristic sound of the female in flight, which is perceived by the long auditory hairs of the male antenna. Males of *C. nubeculosus* also possess these antennal hairs, which are erected during swarming but usually decumbent at other times. Mating in the swarm, and possibly in more confined spaces also, seems to depend on this mechanism; but mating with immobile feeding females must be a radically different case.

Activity of the females. The daily cycle of activity of the females has been investigated by sweep-net collections made at hourly intervals. There are distinct evening and morning peaks of activity, corresponding roughly to the two periods of male swarming. A few females are active also at other times of the day and night. The evening peak is three to four times as great as the morning peak. The excess of females in the evening were found, on dissection, to have large ovaries containing ripe eggs apparently ready for laying. The remainder of the evening fliers, the morning fliers and those taken at other times, almost all had small ovaries with undeveloped oocytes. Females with ovaries in any intermediate condition were rare. It was also very unusual to capture individuals with blood in the stomach.

The females with small ovaries that fly both in the evening and in the morning (perhaps a mixture of newly emerged insects and older ones that have recently oviposited) are probably in search of a blood meal. Having fed, they hide and do not become active again until the meal has been digested and the eggs have matured; they then show only one very sharply defined (evening) period of activity. No such distinction between two age-groups showing different cycles of activity appears to have been made in studies on mosquitoes, possibly because the techniques commonly used are adapted to record only insects that are ready to bite.

Egg-laying. When an attempt was made to induce evening-caught females with ripe eggs to oviposit, it was found that those set up singly in suitable 3 in. × 1 in. tubes usually failed to lay though they might live for several weeks, whereas others left together in the tube in which they had been collected oviposited overnight. In a small experiment, only one out of ten females in individual tubes oviposited during the night following capture, as against ten out of twelve set up in three groups of four per tube. This remarkable density-dependent factor for oviposition has since been confirmed using laboratory-reared insects. The nature of the factor is unknown, and attempts to observe oviposition in the field were not successful.

Biting and longevity. The Chideock strain of *C. nubeculosus* is being maintained in the laboratory, where the complete life-cycle may be as short as three weeks. Females will not bite until two to three days ld; but an activity factor is also involved, since those kept in 3 in. × 1 in. tubes often refuse to feed t all although given daily opportunities, while those in larger ($1\frac{1}{2}$ cu. ft. approximately) cages almost all bite on the third day after emergence. Egg-laying takes place, if the females are suitably concentrated, four to five days after the blood meal, and the insect is then ready to bite again immediately and in due course to lay. As many as five successive batches of eggs have been obtained from a single female; mating in this case had taken place once only (at the time of the first blood meal), but more than 80 per cent of each batch hatched. Adult females may live for rather more than a month.

A fuller account of these studies is in preparation.

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CARNEGIE UNITED KINGDOM TRUST

ANNUAL REPORT FOR 1949

THE booklet issued by the Library Association in connexion with the centenary of the passing of the first Public Libraries Act pays tribute to the part played by the benefactions of Andrew Carnegie in stimulating progress. The thirty-sixth annual report of the Carnegie United Kingdom Trust covering the year 1949* fittingly gives a detailed account of what the trustees have done for the development of library services, more especially as their decision to rehouse the Scottish Central Library seems likely to be their last major contribution in this field. One of their first decisions, on December 22, 1913, was to commission a report on the results of the library grants already given by Mr. Carnegie and on possible future lines of work.

During 1915–19 the Trust made grants to nineteen county councils to enable them to provide and maintain collections of books which would circulate among their villages, and in 1916 the Central Library for Students, known since 1930 as the National Central Library, was founded with the aid of a grant from the Trust, the immediate aim of the Library being to improve the supply of books to students in organised classes of adult education. The Scottish Central Library was established by the Trustees in 1921, primarily as a repository to supplement the resources of the fifteen Scottish county library systems and to supply books to individual readers in other counties. The Irish Central Library was established in 1923, on an earlier scheme for supplying rural libraries with loan collections of books. The period of the Trust's help to the three Central Libraries is now drawing to a close. The grant to the National Central Library, due to finish in 1941, was renewed, as an exceptional measure, during the Second World War and the subsequent five years and will terminate early in 1951. The Irish Library also receives a diminishing grant due to terminate in 1953; but the date at which the Scottish Library will become wholly independent of Trust grants is still uncertain.

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* Carnegie United Kingdom Trust. Thirty-sixth Annual Report, 1949. Pp. viii+44. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

Since 1922 the Carnegie Trust has also made grants to the libraries of learned societies participating in the 'outlier library' system associated with the National Central Library, and help has also been given to the regional system of library co-operation, particularly for the compilation of a nucleus union catalogue of all the books available. With grants from 1926 onwards, for book purchase by small municipal libraries, and for supplying basic collections of books to boys' and girls' clubs, to the National Library for the Blind, the Seafarers' Education Service and the British Sailors' Society, as well as to institutions which exist to improve the general standard and status of librarianship, the total expenditure of the Trust upon library services, when existing commitments have been discharged, will amount, in round figures, to £1,640,000.

In the field covered by the Arts Committee of the Trust, the chief event of 1949 was the creation of the independent Drama Board. Financial considerations have precluded the trustees contemplating the establishment, as recommended in the Younghusband report, of a Carnegie School of Social Work, in association with an appropriate university, but a grant of £200 has been made to enable the National Federation of Women's Institutes to repeat in the Isle of Man the pioneer work carried out successfully in the Channel Islands. Satisfactory progress is reported in the two schemes concerned with juvenile delinquency and also from the Young Farmers' Clubs. The Mobile Club experiment in the Island of Mull has led to the formation of the permanent youth clubs and to appointment by the local education authority of a permanent youth officer for the island.

SIDNEY GILCHRIST THOMAS

THE centenary of the birth of Sidney Gilchrist Thomas on April 16, 1850, was commemorated by the Iron and Steel Institute by a special lecture, delivered by Mr. James Mitchell on April 26 during the annual meeting of the Institute.

Educated at Dulwich College and the Birkbeck Institute, London, Thomas intended to adopt medicine as a career; but the untoward death of his father compelled a change of plan. He became a clerk at the Thames Police Court in 1867; but he spent his time outside office hours in the study of science, taking such examinations in metallurgy of the School of Mines as were open to him as an external student. His interest in the removal of phosphorus from iron appears to have been aroused about 1870 while still a student at the Birkbeck Institute. From a study of the available literature he concluded that the non-removal of phosphorus in the Bessemer process was due to the siliceous lining of the converter and the siliceous character of the slag. A period of experimental work at home, later continued by his cousin, Percy Gilchrist, chief chemist at the Blaenavon Works, followed, and in a comparatively short period of time he was able to announce to the Iron and Steel Institute the discovery of the basic Bessemer process, by which ductile steel could be made from pig iron high in phosphorus, a discovery which, by opening up a new section of the iron-bearing riches of the world, revolutionized the steel industry.

The story of his announcement is dramatic. In September 1878 Lowthian Bell read a paper before the Iron and Steel Institute "On the Separation of Phosphorus from Pig Iron", in which, working on the reactions, as they conceived them, which occur in the puddling process for the production of wrought iron, Bell and other metallurgists were endeavouring to eliminate phosphorus by washing processes, the chemical detergents being oxide of iron and similar materials. The most interesting feature of the discussion of this paper was that it provided the opportunity for Thomas to make the first public intimation of his own success in solving the great metallurgical problem of the time. An eye-witness records: "I remember distinctly the pitying smile of derision and the stony stare which pervaded the countenances of the distinguished assemblage. No one thought it worth while to refer to Mr. Thomas's claim or ask him 'How he did it'."

Within a year a paper was presented which was to establish the truth of the young man's claim. A paper by Thomas and Gilchrist on "The Elimination of Phosphorus" was prepared for the autumn meeting of the Institute held in Paris in 1878. The time, however, was not available to permit of it being read and discussed; but at the spring meeting of the following year a complete process, commercially proved, was given to the world. The delay at the Paris meeting had one further important, and probably decisive, result on the development of the process. The pre-print of the paper and a meeting with Thomas interested Mr. E. Windsor Richards so much that he obtained the consent of his directors to proceed immediately with trials on a works scale at Bolckow Vaughan's plant at Middlesbrough, the results of which added immeasurably to the rapid commercial development of the process. When in due course the subject was discussed by the Iron and Steel Institute during the spring of 1879, the meeting took a form which can be described without exaggeration as an international symposium, the speakers taking part coming from almost every country which at that time had an interest in the solution of the phosphorus problem. The basic Bessemer process was born.

Thomas was industrious to a remarkably high degree, with a highly developed sense of duty and responsibility, and a capacity for liking, and being liked, by a wide diversity of people. It is on record that he appealed to such very different individuals as Andrew Carnegie and William Ewart Gladstone. There is a repeated suggestion in his letters of a strong sense of fun, maybe even of mischief. He certainly possessed the truly great man's first essential characteristic of being ironically amused at his own apparent importance in the sight of others. He had a streak of almost super-caution, and did not relinquish the small but sure competence of his salary as a clerk of the Thames Police Court until the first royalties from his process became available. He also had 'an eye to the main chance', but it was an altruistic eye. Much more successful than many luckless inventors of the period in securing a substantial financial return from his invention, it is worth recalling that these gains—and they must have been considerable—were left, on his early death in 188 to his sister for the benefit of the workers, or, as he wrote to her, "in doing good discriminately". For our purposes his outstanding characteristics were his pertinacity, patience, and a real ability to lead and inspire those with whom he was associated. Attractive as it may be to dwell on what must have been a very pleasing personality, it is his immense contribution to technical knowledge, the methods by which he made it, and their implications, which still remain important to-day.

F. C. T.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Reaction of Methæmoglobin with Hydrogen Peroxide

It was previously shown[1,2] that methæmoglobin forms with hydrogen peroxide and ethyl hydroperoxide reversible compounds analogous to those which it forms with cyanide, sulphide, azide and fluoride. By spectroscopic and manometric methods it was demonstrated that the formation of methæmoglobin–peroxide requires one molecule of peroxide per iron atom of methæmoglobin[1]. The striking resemblance of methæmoglobin to peroxidase and catalase suggested that further study of the reaction between methæmoglobin and hydrogen peroxide might help to clarify certain points concerning these enzymes, and in particular the mechanism of catalatic decomposition of hydrogen peroxide to molecular oxygen and water.

Methæmoglobin was obtained from catalase-free crystalline horse oxyhæmoglobin by treatment with sodium nitrite or potassium ferricyanide and subsequent dialysis. The quantity of hydrogen peroxide added to it will be expressed in terms of the molar ratio (R) of hydrogen peroxide to hæmatin.

At pH 6·8, methæmoglobin is distinctly brown and shows the spectrum characteristic of the acid form with a band in the red at 635 mμ. On addition of a small amount of hydrogen peroxide the solution turns from brown to red and the absorption spectrum of acid methæmoglobin is replaced by two bands α, 585 and β, 545 mμ, the β-band being stronger than the α-band, which is diffuse and somewhat asymmetric. This change in colour and absorption spectrum is due mainly to the formation of a methæmoglobin – peroxide compound (abbreviated to MetHb-OOH), and its formation is 80 per cent complete when $R = 1$. When $R = 2·5–5$, MetHb-OOH is completely formed; but on standing it decomposes, liberating acid methæmoglobin. During this process part of the methæmoglobin undergoes destruction.

These events have already been described in our previous paper[1], where we have also recorded that the α-band of MetHb-OOH is not only asymmetric but may even appear to have two maxima. The complex nature of this absorption band, together with the fact that both catalase and peroxidase form with hydrogen peroxide several spectroscopically recognizable compounds, has prompted us to examine more closely the spectroscopic changes which accompany the reaction between methæmoglobin and hydrogen peroxide. The double appearance of the α-band with maxima at 592 and 578 mμ becomes more marked as the concentration of hydrogen peroxide is increased. When $R = 25$ the α-band is distinctly double and its components are of almost equal intensity. When $R = 100$ the shorter wave-band at 578 mμ is distinctly stronger than the other band at 592 mμ. When R reaches 250–500, the band at 578 mμ predominates, and after a short time it completely replaces the longer wave-band.

Thus in presence of an excess of hydrogen peroxide, the MetHb-OOH is gradually replaced by another compound, which is easily recognized as oxyhæmoglobin by the positions and relative intensities of its absorption bands as well as by its reaction with carbon monoxide. (That oxyhæmoglobin may be formed as a result of the reaction between methæmoglobin and hydrogen peroxide was already suggested to us in 1936 by Dr. R. D. Barnard[3].) In other words, the trivalent iron of the methæmoglobin – hydrogen peroxide complex, in presence of an excess of hydrogen peroxide, undergoes reduction to the divalent state to yield hæmoglobin, which is oxygenated to oxyhæmoglobin.

Of special interest, however, is the fact that bubbles of oxygen deriving from decomposition of hydrogen peroxide do not appear until the α-band of oxyhæmoglobin becomes visible, and active decomposition of peroxide takes place only when the bands of oxyhæmoglobin are already very marked. This clearly shows that the reaction between methæmoglobin and hydrogen peroxide consists in the formation of MetHb-OOH, which, on further reaction with hydrogen peroxide, brings about its decomposition to molecular oxygen and water, a reaction which is accompanied by valency changes of methæmoglobin iron. In connexion with this reaction, the following points are noteworthy:

(1) The greater the excess of hydrogen peroxide added from the beginning, the more rapid and complete is the formation of oxyhæmoglobin and the more vigorous is the decomposition of hydrogen peroxide. But, however great is the excess of hydrogen peroxide, the appearance of oxyhæmoglobin is always preceded by a transient stage of complete formation of MetHb-OOH.

(2) When the relative concentrations of these two compounds are equal, the α-band of oxyhæmoglobin would appear much stronger than that of MetHb-OOH, since the absolute extinction of its α-band is much greater than that of MetHb-OOH.

(3) The catalatic decomposition of hydrogen peroxide, together with the appearance of oxyhæmoglobin, is soon followed by destruction of the hæm nucleus, since the absorption bands gradually disappear and the solution becomes colourless.

(4) On addition of a suitable acceptor, such as ascorbic acid, which can be oxidized peroxidatically, to a solution showing the absorption bands of oxyhæmoglobin and MetHb-OOH, the latter is rapidly decomposed, liberating methæmoglobin, while oxyhæmoglobin remains unchanged.

(5) All these reactions have been observed with both recrystallized methæmoglobin and metmyoglobin in solutions at pH's varying between 5·5 and 9·2.

Since the peroxidatic and catalytic activities of methæmoglobin, although much lower than those of peroxidase and catalase, are nevertheless very distinct, methæmoglobin can be considered as a suitable model for the study of the reactions catalysed by these two enzymes. As the catalytic decomposition of hydrogen peroxide by methæmoglobin to oxygen and water involves the formation of MetHb-OOH and subsequent valency changes of the methæmoglobin iron, it is reasonable to assume that the similar decomposition of hydrogen peroxide by catalase is also accompanied by valency changes of catalase iron. This view, moreover, is supported by evidence obtained from the study of azide-catalase[4-6]. That a transient divalent state of catalase iron during normal catalatic activity has not so far been directly observed even by rapid flow methods may be due to an unusually high velocity of re-oxidation of this ferrous catalase. In fact, the reaction of the primary catalase – hydrogen peroxide complex with further hydrogen peroxide results, according to Chance[7], in the formation of an "as yet undetermined complex which rapidly decomposes". It is probably within the very brief period of formation and decomposition of this complex, which is responsible for the catalatic decomposition of hydrogen peroxide, that valency changes of catalase iron take place.

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Partial Protection by Cortisone against Renal Lesions produced by Hypolipotropic Diets

A RELATIONSHIP has been shown between metabolic activity and the severity of lesions produced by feeding rats a diet low in choline and its precursors[1]. Cortisone (11-dehydro-17 hydroxycorticosterone acetate) is known to influence many metabolic processes[2], and it seemed possible that it might modify the effects of acute choline deficiency in weanling rats. Experiments have been carried out to study this possibility.

In four experiments a total of a hundred male rats of the Wistar strain, weighing 36–50 gm., were kept in individual metal cages, offered water *ad libitum*, and fed diets low in choline and its precursors, but otherwise adequate for good growth. In three experiments feeding was *ad libitum*; but in the fourth the animals were 'pair fed'. Fifty of the rats were given a daily subcutaneous injection of 0·5 or 1 mgm. of cortisone in saline. The remainder were injected with similar volumes of saline alone.

After eight days, all rats were sacrificed, and chemical and histological examinations were undertaken. Grossly, the kidneys of the controls were invariably swollen and "hæmorrhagic"[3], while those from the rats treated with cortisone varied in appearance from the normal to one indicating a lesion of moderate severity. Microscopically, the difference between the two groups was even more pronounced. The controls showed the renal changes expected, including subcapsular and cortical hæmorrhages, casts, and swelling of the tubular epithelium. The kidneys of the treated animals were frequently within the limits of normal; but in the majority of cases damage of a similar type but of a lesser degree than that in the controls was present.

In the *ad libitum* experiments the rats given cortisone ate more food (in one experiment 4·6 gm. compared with 3·0 gm. per day) and gained more weight (average gain of 1·4 gm. compared with average loss of 2·4 gm.) than the controls. The increased intake of the hypolipotropic diet, without cortisone, would have intensified the renal lesions. The deposition of excess liver fat was not affected by cortisone.

The mechanism and significance of this *partial* protection by cortisone against renal damage produced in young rats by choline deficiency are not apparent, and further investigations are in progress.

The cortisone was obtained from Merck and Company, Montreal, through a special grant from the National Research Council of Canada.

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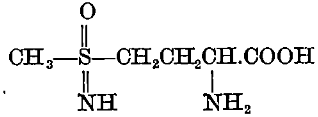
Toxic Factor from Agenized Proteins: Infra-red Examination

As a result of detailed chemical investigations on the nature of the toxic factor produced by the action of nitrogen trichloride ('Agene') on flour, Bentley, McDermott, Pace, Whitehead and Moran[1] have isolated a compound with empirical formula $C_5H_{12}N_2O_3S$, which appears to be responsible for the toxicity. They have suggested that this compound is a derivative of methionine, with the probable structure (I).



$$CH_3-\underset{\underset{NH}{\|}}{\overset{\overset{O}{\|}}{S}}-CH_2CH_2\underset{\underset{NH_2}{|}}{CH}.COOH \qquad (I)$$

These workers have supplied us with samples for infra-red examination, both as a possible check on the structure and also in order to establish the identity of synthetic specimens. The substances have been measured as solids suspended in paraffin or perfluorokerosene, using a Perkin Elmer 12 *C* spectrometer over the range 2–15 μ.

The spectrum of the toxic factor (*X*) is compatible with its being a derivative of an amino-acid, particularly near 6 μ and 3 μ, and with a weak band near 5 μ; but it has two strong bands near 1,000 cm.$^{-1}$ and 1,200 cm.$^{-1}$. It is already known[2] that sulphoxides give rise to a band near 1,000 cm.$^{-1}$, sulphones at 1,100 cm.$^{-1}$ and 1,300 cm.$^{-1}$, and we have now found a similar band with methionine sulphoxide and S-methyl cysteine sulphoxide. Further, it appears that the band in *X* near 1,000 cm.$^{-1}$ can be attributed to the S=N link, since it is found in the spectrum of synthetic $(CH_3)_2\,S\begin{smallmatrix}\diagup O\\ \diagdown NH\end{smallmatrix}$ and of synthetic preparations of methionine sulphoximine and S-methyl cysteine sulphoximine in which the S=O band lies near 1,200 cm.$^{-1}$. The possibility that these compounds have isomerized to form a compound analogous to the oximes $\rangle S=N-OH$ appears to be excluded on both chemical and spectroscopic grounds.

The toxic factor *X* was separated by the abov workers into two fractions *A* and *B*, thought to b diastereoisomers, *A* being the more potent. Th spectrum of *A* showed marked differences from tha of *X*, but was identical with that of the syntheti sulphoximine from L-methionine. The spectrum o the sulphoximine made from DL-methionine differe from that of *A* in small features of the kind expected of such isomers; but in several spectral regions it was unlike that of *B*, which resembled *X* very closely. This close similarity of *B* with *X*, and the relationship between *A* and *B*, are being examined further.

The spectra suggest that in some of these compounds where there is a long molecular skeleton, some of the main groups such as NH and C:O are affected by hydrogen-bridge formation, which varies according to the particular skeleton.

The main point is that the spectra support the suggestion that the sulphoximine of methionine is an essential part of the toxic factor. Details of this work will be published later elsewhere.

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Reduction in Lethal Effect of X-Radiation by Pretreatment with Thiourea or Sodium Ethane Dithiophosphonate

DALE *et al.*[1] showed that carboxypolypeptidase could be protected *in vitro* against X-radiation by a variety of substances. One of these, thiourea, is shown below to reduce the mortality following whole-body irradiation of mice. We also tried a few other substances, selected, like thiourea, in the hope that they would enter cells without being too toxic or too rapidly metabolized, and would protect by competing for hydroxyl radicals. The effect of sodium ethanedithiophosphonate is of added interest because sodium ethane-monothiophosphonate protects weakly against the radiomimetic substance *bis*-chlorethyl sulphide (mustard gas)[2].

The irradiation technique will be described in fuller detail later. Mice of a *CBA* strain were used, irradiated in groups of four in the specially designed aluminium boxes in which they normally lived. The X-irradiation factors were: 240 kV. 15 m.amp. H.V.L. 1·14 mm. copper, tube distance 167·5 cm., dose-rate 7·59 r./min., dose measured inside cages containing bedding, food hopper and water bottle. By irradiating from below and inserting a stepped aluminium filter, a field uniform to within ± 3 per cent was achieved. Four boxes were irradiated at a time. Test substances were administered intraperitoneally in approximately isotonic solution a few minutes before or after irradiation, using saline as a control.

In experiment 1 a single dose of 875 r. was given. In experiment 2 a sublethal dose of 600 r. was given; three months later the injections were repeated and 875 r. was given. The accompanying table shows that the apparent protective effects of thiourea and dithiophosphonate were highly significant ($p \ll 0{\cdot}01$) and of glycerol barely so ($p = 0{\cdot}08$). It is also clear that thiourea given immediately after the irradiation was ineffective and that saline was not deleterious.

The *CBA* strain used responds very uniformly to radiation and, as judged by the slope of the dose-mortality curve in uninjected controls, the reduction in mortality in experiment 1 is equivalent to a reduction of only 10–15 per cent in the efficiency of the radiation, although the test substances were used in amounts not far from the maximum tolerated. In some circumstances radiation seemed to potentiate the toxic effects of thiourea.

A protective effect has been reported for cysteine[4], for glutathione[5] and for cyanide[6]; but the equivalent reduction in radiation efficiency was not stated.

We are grateful to the staff of the Unit for help with these experiments, and to its director, Dr. J. F. Loutit, for his interest and encouragement.

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Experiment	Age of mice at beginning of experiment	Sex	Material injected intraperitoneally	No. of mice	No. dying within 30 days	Mean number of days to death	Survival per cent	*p* for difference in mortality from group given saline*
1	9 weeks	Male only	2 ml. 0·15*M* saline before	20	18	11·8	10	—
			2 ml. 0·28*M* thiourea before	16	8	14·3	50	0·01
			2 ml. 0·28*M* thiourea after	12	12	11·0	0	—
			No injection	12	12	11·3	0	—
2	14 weeks	Male and female in equal numbers	2–3 ml. 0·15*M* saline	6	6	11	0	—
			2 ml. 0·28*M* thiourea	8	1	26	88	0·002
			3 ml. 0·1*M* sodium ethanedithiophosphonate	7	1	13	86	0·004
			2 ml. 0·28*M* glycerol	8	4	11½	50	0·08
			2 ml. 0·1*M* sodium thiosulphate	8	5	13	38	0·15
			3 ml. 0·1*M* sodium dithionate	8	8	14	0	—

* *p* was calculated by the exact method for 2 × 2 contingency tables (ref. 3).

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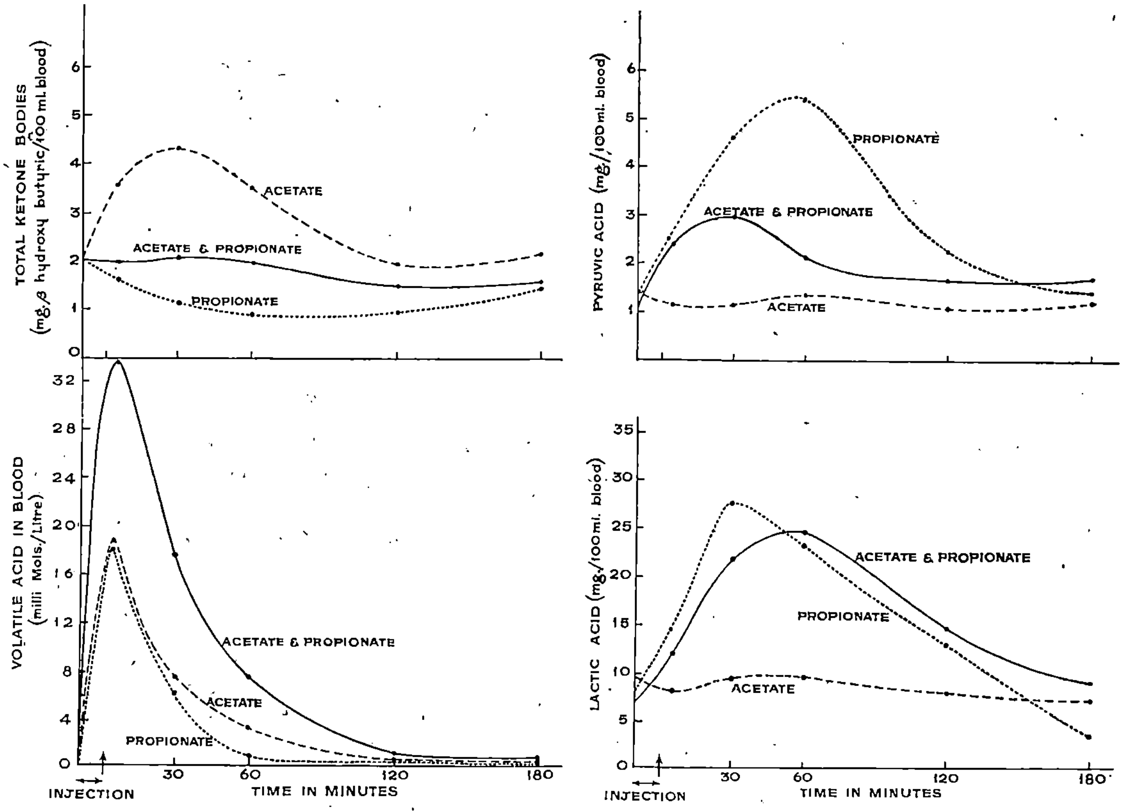
Metabolism of Acetate and Propionate in the Ruminant

THE volatile acids, acetic, propionic and butyric, which are formed by bacterial fermentation in the paunch of ruminants, assume an important role in the metabolism of these animals. In view of the relatively large amounts of acetate and propionate absorbed, the subsequent metabolic routes of these compounds are of considerable interest, not only from the aspect of the intermediary metabolism of each



individually, but also because of any possible inter-relationships which may exist between them.

The concentrations of ketone bodies, of sugar, and of lactic and pyruvic acids were determined in the blood of sheep concurrently with those of the volatile fatty acids subsequent to the intravenous injection of 5 m.*M*/kgm. of acetic or propionic acids, or of a mixture of the two. The solutions used in these experiments were neutralized to *p*H 7·0 with caustic soda; the volume was 120 ml. for the individual acids and 240 ml. for the mixture.

The animals were kept in metabolism cages which reduced their activity to a minimum and yet permitted freedom of movement. A fine plastic tube (1 mm. internal and 1·7 mm. external diameter) was inserted for several inches into the jugular vein on the day preceding the experimental period, and a slow intravenous infusion of saline was maintained to reduce the possibility of blood clots occurring in the tube. Blood samples were obtained with a minimum of handling by attaching a syringe to the end of the tube. This allowed the animal to remain placid throughout the manipulations, a condition which is essential for such experiments as these, in which activity very materially influences the concentration of lactic and pyruvic acids in the blood.

After the pre-injection levels had been determined, the solutions were administered over a period of 5–10 min. Blood samples were then taken subsequent to the injection at 5, 30, 60, 120 and 180 min. Acetate was given on the first day of the experimental period and followed on successive days by the propionate, then the mixture, and occasionally by a hypertonic solution of saline.

The volatile acids were estimated by a modification of the method of Friedemann[1], the ketones by the method of Weichselbaum and Somogyi[2], the lactic acid by the method of Edwards[3], the pyruvic acid by the method of Friedemann and Haugen[4], and the sugar by the Somogyi method[5].

The diagrams illustrate the response of an animal typical of the others in the series. The tolerance curves for the volatile acids indicate that propionate is removed more rapidly from the blood stream than acetate. Concentrations of lactic and pyruvic acids and of sugar show that acetate alone was ineffective in causing any significant rise in these glucogenic intermediaries present in the systemic circulation. Propionate, however, did produce a marked increase in the blood levels of these substances; with the mixture of acetate and propionate, the levels were raised, but in the case of pyruvic acid to a lesser extent than with propionate alone.

The main interest in these observations centres around the ketone production. The ketogenic effect of acetate is evident from the increase in the ketone body concentration of the blood following its injection. The administration of propionate, however, brought about a reduction in the level of circulating ketones. The presence of the propionate in the equimolar mixture of acetate and propionate prevented the rise that normally would have followed the injection of the same amount of acetate unaccompanied by the propionate.

If the oxidation of fatty acids proceeds via the cyclophorase system[6], then it is likely that oxaloacetate, or one of its precursors, plays an important part in a condensation reaction with acetate or acetoacetate. The fact that propionate can lead to a rise in pyruvic acid, a known precursor of oxaloacetate, lends support to the suggestion that, in the ruminant, oxidation of acetate may be linked with that of propionate. As the utilization of acetate is facilitated by the presence of pyruvic acid[7], the relatively limited supply of glucose available to the ruminant may then place greater stress on the concurrent supply and metabolism of propionate.

In view of our observations, the oxidation of acetate or acetoacetate, may be impaired, with the possible development of ketosis, if the metabolism of propionate in the ruminant is in any way inhibited. Details of this experimental study will be published elsewhere.

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Additional Transaminations by Insoluble Particle Preparations of Rat Liver

Braunstein and Kritzmann[1] suggested that transamination in pigeon breast muscle was a general reaction involving most of the amino-acids; Cohen[2] was unable to confirm these results, and pointed out the lack of experimental controls. Further work by Cohen[3] with purified enzyme preparations suggested that the transamination reactions were limited to

L-glutamate + oxalacetate ⇌ α-ketoglutarate + L-aspartate

and

L-glutamate + pyruvate ⇌ α-ketoglutarate + L-alanine.

Slower but significant reactions with other amino-acids have been shown to occur in kidney and liver homogenates by the same author[4]. Various workers[5-8] minimized these findings when assessing the general significance of transamination reactions.

Schoenheimer and colleagues[5] have shown that all but arginine and lysine, of many essential amino-acids investigated, interchange α-amino groups during protein turnover. Feeding experiments with α-keto and α-hydroxy analogues of many essential amino-acids have also clearly shown that the animal ody possesses some mechanism for their amination, o form the corresponding amino-acids. (See Bubl and Butts for a short summary of these experiments[9].)

Accepting the current opinion of the limited scope of he transamination reaction, we set out to investigate he possibility that glutamine might, with a hydrogen onor, transfer its amide nitrogen to α-keto acids. s a guide for accurate work, paper chromatography[10] uggested itself as a convenient and approximately uantitative method for following the specific ntheses of amino-acids, by reactions of this type.

For the enzyme preparations, fresh rat liver was omogenized with two parts of ice-cold phosphate uffer, *p*H 7·8, and washed free of endogenous subrates by high-speed centrifugation. The sediment as made up to the original volume with buffer. 1 ml. of this preparation was incubated anaerobically at 37° C. for 30 min. with either $M/20$ glutamine or glutamate, and $M/20$ or $M/40$ α-keto acid, in a total volume of 2 ml. Proteins were then precipitated from the incubation mixtures by the addition of two volumes of warm ethanol. After centrifuging, the supernatant was evaporated to dryness *in vacuo* and taken up to the original incubation volume with water. For chromatography 1 μl. of this solution was used, and, with suitable solvents, runs of one to two hours were sufficient to effect a good separation of the amino-acids concerned.

Phenylpyruvic was used as the α-keto acid in the initial experiments. While a synthesis of phenylalanine occurred when glutamine was added with a hydrogen donor (coenzyme I and β-hydroxybutyrate), a much greater synthesis was achieved in the ammonium glutamate control experiment. Ammonium chloride, with added hydrogen donor, was not effective as an aminating agent in this system, whereas sodium glutamate was found to be just as effective as ammonium glutamate. This was taken as clear evidence that transamination from glutamate to phenylpyruvate does occur in rat liver. The tissue preparations used in these experiments showed strong glutaminase activity, and it would probably be through the intermediate formation of glutamate that glutamine brings about the amination of phenylpyruvate.

It was found that the glutamate–phenylpyruvate transaminase was located solely in the insoluble particle fraction of rat liver homogenates. Transamination to form tyrosine, alanine and aspartate was also catalysed by these particle suspensions. Mitochondrial preparations, obtained by differential centrifugation[11], were found to be active in pro-

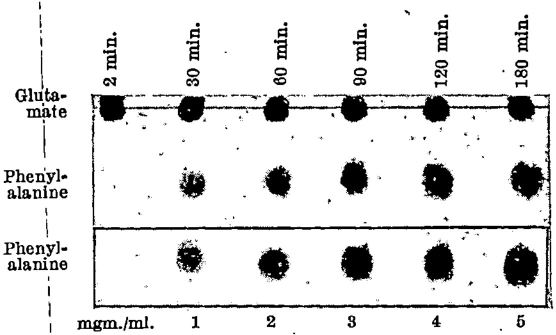

Fig. 1. Progress chromatogram showing phenylalanine synthesis from glutamate ($M/20$) and phenylpyruvate ($M/20$); separate chromatogram of known amounts of phenylalanine set underneath for comparison. Solvent system: collidine, water-saturated

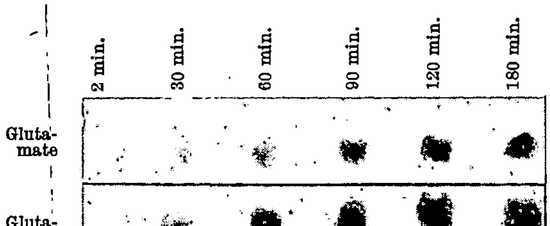

Fig. 2. Progress chromatogram showing glutamate synthesis from phenylalanine and α-ketoglutarate (both $M/20$); separate chromatogram of known amounts of glutamate set underneath for comparison. Solvent system: propanol water, 80/20

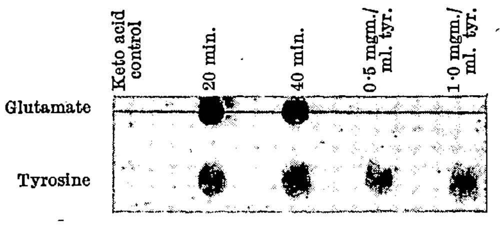

Fig. 3. Progress chromatogram showing synthesis of tyrosine from glutamate ($M/20$) and p-hydroxy-phenyl-pyruvate ($M/40$). Known amounts of tyrosine chromatographed on the same paper. Solvent system: collidine, water-saturated

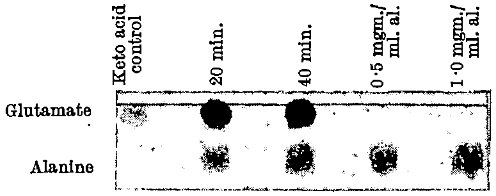

Fig. 4. Progress chromatogram showing synthesis of alanine from glutamate ($M/20$) and pyruvate ($M/40$). Known amounts of alanine chromatographed on the same paper. Solvent system: propanol water, 80/20

moting the syntheses of these four amino-acids by transamination, suggesting that the mitochondria may be the site of these reactions. The dialysed supernatant, on the other hand, catalysed transamination between glutamate, aspartate and alanine only. The rate of formation of phenylalanine in experiments with the insoluble fraction was found to be comparable with the rate of alanine formation in the soluble supernatant, both fractions of the homogenate being made up in the same volume.

It can be seen from the chromatograms (Figs. 1, 3 and 4) by comparison with adjacent known amounts, chromatographed similarly, that a substantial synthesis of phenylalanine, tyrosine and alanine is catalysed by the insoluble particle preparations.

Progress chromatograms of the reaction

$$\text{L-glutamate} + \text{phenylpyruvate} \rightleftharpoons \alpha\text{-ketoglutarate} + \text{L-phenylalanine}$$

show by comparison with adjacent known spots (run on paper in the same way) that the reactions are slow to reach equilibrium (Figs. 1 and 2). The half-way point (when there would be approximately 4 mgm./ml. of each reactant present) has not been reached either in the formation of glutamate or of phenylalanine. The formation of glutamate has also been shown to occur, qualitatively, by paper chromatography, when tryptophane, valine, leucine, histidine or glycine are each incubated with α-ketoglutarate in the presence of the insoluble particle preparations.

The particle-bound enzyme system revealed above may well be concerned in the amino-group exchange and α-keto acid amination which occur in intact animals[5-9]. Preoccupation with the soluble enzyme preparations which catalyse aspartate, alanine and glutamate amino-group exchanges has tended to divert attention from the more general transamination reactions of the cell, the existence of which is now confirmed.

We wish to thank Dr. M. Dixon and Dr. C. S. Hanes for their interest and advice during the course of this work. One of us (E. V. R.) wishes to acknowledge a grant from the Medical Research Council.

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Stabilization of Edible Fats by Condiments or Spices

Fortification of edible oils and fats against oxidation and rancidity is essential from the point of view of smell, taste and colour of the materials; further, oxidized and rancid oils have injurious physiological effects on the human system. For human consumption, refined oils are generally used; but they lose their natural antioxidants during processing. A difficulty in stabilizing edible fats is that, except for a few substances such as N.D.G.A., lecithin, tocopherols, kamla dye and oat flour, most antioxidants are toxic. N.D.G.A. is very sparingly soluble in oils and kamla dyes fat orange.

From very early times in India it has been customary to add to edible fats, especially rendered butter-fat (ghee), such spices or condiments as garlic and red chillies. In the preparation of pickles, the oils are added after heating them to incipient charring with small quantities of red chillies, fennel, asafœtida, caraway or cloves.

It is of interest to find out whether the use of such substances has a scientific justification in stabilizing edible oils and fats. Refined groundnut oil wa heated with definite amounts of spices or condiment up to 275–280° C. so that charring occurred. Th oil was then cooled and filtered. The material wa subjected in each case to the 'swift stability test' a 100° C., the oxidation period being five hours in eac case. The peroxide and acid values of these oil were compared with those of the original oils an with those of similarly heated oils without additio all being submitted to the oxidation test. Th accompanying results demonstrate that spices an condiments are actually effective preservatives fo refined groundnut oil. This is seen by the low peroxi and acid value as compared with those of the contro 76·9 and 0·99 respectively.

As was expected, heating the oil at 275° C. decon posed some of the peroxides. The oils so treate with the addition of spices, were found to have n perceptible taste or odour.

Thus once more an age-old custom of mankind now found to have a sound scientific basis.

Spice or condiment	Quantity used (%)	Peroxide value	Acid value
Original oil before any treatment	—	7·05	0·51
Oil after aeration	—	100·50	1·05
Oil heated to 275° C.	—	1·20	0·41
Oil heated to 275° C. and aerated (control)	—	76·90	0·99
Red chillies	0·50	23·40	0·58
	1·00	12·50	0·47
	1·50	7·10	0·44
Green chillies	2·00	16·10	0·54
	3·00	13·80	0·50
	5·00	11·80	0·43
Cinnamon leaves	0·50	12·80	0·52
	1·00	8·50	0·51
	1·50	7·50	0·50
Cinnamon bark	0·50	31·30	0·45
	1·00	20·60	0·44
	1·50	16·70	0·44
Dry ginger	0·50	19·80	0·51
	1·00	14·40	0·50
	1·50	9·90	0·48
Green ginger	2·00	26·10	0·52
	3·00	16·20	0·45
	5·00	12·50	0·43
Tumeric	0·50	25·20	0·47
	1·00	15·10	0·35
	1·50	9·50	0·32
Nutmeg fruit	0·50	20·10	0·63
	1·00	13·10	0·52
	1·50	10·70	0·50
Nutmeg mace	0·50	35·00	0·50
	1·00	15·30	0·46
	1·50	11·80	0·44
Black pepper	0·50	45·20	0·60
	1·00	12·30	0·51
	1·50	10·50	0·48
Cloves	0·50	66·70	0·70
	1·00	16·40	0·55
	1·50	15·70	0·49
Onions	2·00	23·30	0·56
	3·00	17·70	0·45
	5·00	15·60	0·41

Tests with other edible oils and fats, such as sesame, mustard, safflower, and butter-fat (ghee), are in progress. The keeping qualities of these stabilized fats over long periods of time are also being further studied.

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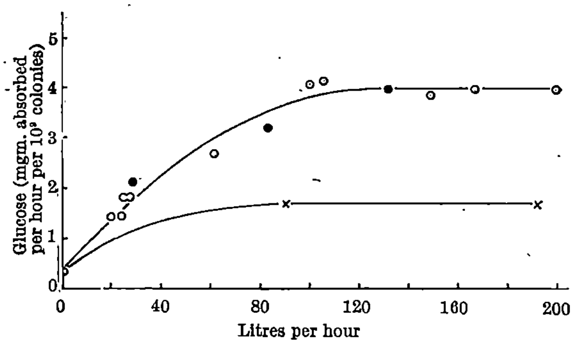
Effect of Aeration on the Absorption of Glucose by a Green Alga

It has recently been shown that aeration of the culture medium brings about increased growth of bacteria[1] and of excised roots[2]. During an investigation of the factors affecting the absorption of glucose by the green alga *Scenedesmus quadricauda*, it was noticed that aeration of the medium resulted in a considerably greater uptake of glucose.

Bacteria-free cultures of *Scenedesmus quadricauda* were grown in an autotrophic culture medium (medium *C* of Österlind[3]) at 25° C. under a constant light intensity of 150 foot-candles supplied by daylight fluorescent tubes. The cultures were centrifuged after eight or nine days growth and suspended in *M*/30 phosphate buffer at *p*H 5·5. 5 ml. of this suspension was introduced into a long black 'Pyrex' tube sealed at one end and immersed in a water bath at 25° C. Air was blown through the suspension through a porcelain bubbler at the bottom of the tube. After half an hour's aeration, to bring the suspension to equilibrium, 1 ml. glucose solution was added and the aeration continued for another two hours. The tube was then washed out into a filter crucible, and the filtrate analysed for glucose by the method of Hanes[4]. In order to reduce evaporation from the suspension, the air was passed through a wash-bottle containing distilled water before entering the tube. The number of four-celled colonies present in the medium was taken as the basis for computing the rate of absorption since this is proportional to the surface area, the most important factor in absorption. The number of colonies in an aliquot of the original suspension was determined by counting at least two hundred colonies in at least three drops.



o—o—, Air; ●—●—, oxygen; ×—×—, nitrogen

The effect of different rates of aeration on the rate of absorption of glucose is shown in the accompanying figure. Up to an aeration-rate of about 100 litres per hour, an increase in the rate of aeration results in an increase in the rate of glucose uptake; but above this, the rate of glucose absorption is independent of the rate of aeration, remaining constant at 3·93 ± 0·17 mgm. glucose per hour per 10^9 colonies. The slope of the first part of the curve can be altered by using different aerating conditions. For example, the rate of glucose uptake increased much more slowly with increase in the rate of aeration when a plain glass tube with no bubbler attached was used, though the limiting value for the rate of glucose absorption was the same under both conditions.

The beneficial effects of the aeration might be due to the oxygen tension in the solution, since Pearsall and Bengry[5] have reported that the rate of oxygen uptake of *Chlorella* in an unshaken Warburg manometer is independent of the number of cells in the suspension, and is only one-eighth of the uptake on shaking. It is possible, therefore, that the uptake of glucose is dependent on the oxygen available for respiration. On the other hand, the increase may simply be due to the fact that aeration causes mechanical agitation of the cells in the glucose solution, enabling the cells to receive a greater supply of glucose than when they are stationary on the bottom of the tube. Experiments using pure oxygen, however, showed no significant differences from the corresponding rates in air, suggesting that oxygen tension of the solution is not the main factor determining the rate of uptake of glucose. A very low rate of glucose uptake is possible under static conditions, presumably due to the absorption of glucose by the uppermost layer of algæ.

That the presence of oxygen does have an effect on the absorption of glucose can be seen by determining the rate when nitrogen is bubbled through the suspension. Under these conditions the rate of uptake is much lower than with air or oxygen. Thus although aeration has its main effect through mechanical agitation, the absence of oxygen results in a considerable lowering of the rate of glucose uptake.

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A Probable Deletion in a Human *Rh* Chromosome

A SAMPLE of blood sent to us because of the presence of most unusual antibodies has proved, on investigation, to have even more extraordinary *Rh* antigens. The blood is unique in our experience, and in the literature, in that it has the antigen D, but lacks any detectable representative of the C and E allelomorphic series of antigens.

The donor of the blood is homozygous for this deficiency, owing without a doubt to her parents being half second cousins. Her mother is heterozygous for the condition; her father and two brothers are dead.

The genotype of the donor may be written —D—/—D—, the dashes representing the absence of C, c, C^w, c^v, C^u and the absence of E, e, E^u. The absence of these antigens was demonstrated by negative results of agglutination tests in saline and in albumin, of indirect anti-globulin tests, of trypsin tests and of absorption tests. The presence of an abnormal amount of the D antigen was demonstrated by the much greater power of the —D—/—D— blood to absorb anti-D compared with that of CDe/cDE blood; it was also shown in comparative tests with CDe/cDE and cDE/cDE cells against titrations of incomplete anti-D in albumin; it was shown most strikingly of all by the unique ability of the cells to be agglutinated in saline by incomplete anti-D (which, incidentally, makes it almost certain that this antibody is not monovalent as it has so often been represented). The somewhat extensive serological details will be recorded elsewhere. Nothing abnormal was found in the other blood groups of the donor.

In the serum of the donor we have so far been able to identify anti-e, anti-C and anti-c. The finding of both anti-C and anti-c in one serum is extraordinary but not altogether unexpected in a person lacking any C or c antigens.

Three possible genetic interpretations suggest themselves:

(1) The C and E loci may be represented by unknown, silent allelomorphs. This is unlikely, for all the known allelomorphs produce antigens which are easily detectable; it is highly improbable because two of this new kind of allelomorph, one at the C and the other at the E locus, would have to be postulated on the same chromosome.

(2) A suppressing gene may be at work. It is difficult to imagine that such a gene would suppress all activity at the C and E loci yet not at the D locus. Moreover, the presence of C or c antigens, even when suppressed, would surely be incompatible with the existence in the serum of both anti-C and anti-c.

(3) Deletion of a portion of the *Rh* chromosome seems to offer the most satisfying explanation. It would fit well with the total absence of the C and E antigens and might explain the exalted D antigen. We have for some time had evidence that suggests that a common basic material of limited amount is available for the production of the C D E antigens. Freed from the competition of C and E, D might take all such hypothetical raw material. That the deletion is probably a short one is suggested by the good health of the donor and by the absence of any other congenital abnormality.

Whatever the exact genetic mechanism, the fact that C and E are involved supports from an unexpected angle Fisher's tentative suggestion[1] that the order of the genes on the chromosome would be found to be D C E. It also seems that the very controversial question whether the genes are separable or not is settled in the most convincing way of all—by their separation.

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Separation and Identification of Sugars using Paper Chromatography

CHROMATOGRAPHY on filter paper has provided an excellent and a much-needed method for the investigation of the structure of polysaccharides[1-5] and proteins[6-10]. While butanol–ethanol–water, butanol–acetic acid–water, and phenol–water are effective mixtures, among others[1], for the separation of a wide variety of sugars[11,12,5] and their methyl derivatives[13], the phenol–water mixture is usually better than either of the other two mentioned above for the separation of unmethylated sugars (cf. ref. 14). The method using phenol–water, however, suffers from the disadvantage that the location of the sugars on the paper by treatment with ammoniacal silver nitrate cannot be accomplished without some difficulty because the paper quickly becomes dark or sometimes black. It is claimed that suitable purification of the phenol either reduces the darkening[5] or eliminates it altogether[15]. We find that most of the darkening can be avoided by extracting the paper with ether before spraying with the silver reagent. By adopting this slight modification, it has been found unnecessary to purify the phenol.

The use of either malonic acid (10 gm.) or propionic acid (10 ml.)[16] in conjunction with butanol (40 ml.) and water (50 ml.) as partitioning solvents has also been shown to avoid the over-all blackening of the paper produced by spraying with the silver reagent and subsequent heating.

Experiments with either of these mixtures are allowed to proceed for 20–25 hr. at about 25° C., after which the paper (Whatman No. 1) is dried in the air and then for 10–15 min. at 100° C. The sugars can then be detected with the ammoniacal silver reagent. When malonic acid is used, it is advisable to extract excess of it with ether after the initial drying and heating at 100° C., otherwise the sensitivity of the silver test is reduced. It is of interest to note that malonic acid prevents spreading of the sugar zones.

When malonic acid is used in the developing solvent, non-reducing oligosaccharides such as sucrose, melizitose and raffinose containing a labile glycosidic bond undergo hydrolysis during the heating at 100° C.; their positions on the paper are then revealed by the cleavage fragments showing a positive test with the ammoniacal silver reagent (cf. refs. 17, 2, 5). Glucose-1-phosphate, likewise sensitive to acid, can also be detected in the same way. The labile non-reducing sugars are not detectable with the butanol–water–propionic acid solvent because the propionic acid is not capable of effecting the necessary hydrolysis; but if the paper is dried and sprayed with the upper layer of the malonic acid–butanol–water mixture and heated at 100°, the non-reducing sugars undergo hydrolysis and their reducing cleavage fragments can be detected. This procedure has also enabled us to detect sucrose, melizitose and raffinose after separation with phenol–water.

In investigating the structure of polysaccharides, we have found methyl-ethyl-ketone saturated with water to be an excellent solvent for the partition chromatography of methylated sugars. This solvent appears to be somewhat better than butanol–ethanol–water[3] and it also has the advantage that its movement on filter paper and columns of cellulose is relatively rapid. Thus it gives a good separation of the 2, 3, 4, 6-tetramethyl glucose, 2, 3, 6-tri- and 2, 3-dimethyl derivatives of D-glucose, the R_F values of which are 0·82, 0·56 and 0·28 respectively. The mixture of the cleavage fragments of many methylated galactomannans, namely, 2, 3, 4, 6-tetramethyl-D-galactose (R_F, 0·68), 2, 3, 6-trimethyl-D-mannose (R_F, 0·50), and 2, 3-dimethyl-D-mannose (R_F, 0·22) can also be resolved with relative ease.

Successful separations of methylated sugars can also be achieved by using the upper layer of a mixture of 90 per cent methyl-ethyl-ketone and 10 per cent petroleum ether (b.p. 100–120° C.) saturated with water. Diethyl ketone saturated with water can also be used.

While many of the partially methylated reducing sugars can be detected by the ammoniacal silver nitrate test, the more highly methylated reducing sugars do not give a good reaction. To overcome this difficulty, the paper may be sprayed with a solution containing the salt of an aromatic base and then heated at 100–130° C. The following bases have been found useful: (*a*) aniline, (*b*) amino-dimethyl benzene, (*c*) *p*-phenylene diamine, (*d*) *p*-amino-dimethyl aniline, (*e*) *p*-amino-diethylaniline and (*f*) N (1-naphthyl)-ethylene-diamine. Of these (*d*) and (*e*) are particularly effective, inasmuch as the colours produced depend not only on the degree of methylation, but also upon the position of the methyl group (cf. refs. 18, 19). Methyl derivatives of ketoses are readily ocated by (*f*). We have found that hydrochloric, formic, trichloracetic and toluene sulphonic acid may be used in conjunction with the above bases. Such sprays containing salts of aromatic bases will readily locate free sugars, the non-reducing sugars such as sucrose, raffinose and melizitose and certain glycosides.

All the free sugars and some polyhydric alcohols such as sorbitol, mannitol and inositol can be detected by spraying with a solution of silver oxide in ammonia, followed by washing with ammonium hydroxide.

Paper partition chromatographic studies of the dimethyl glucose fragment of methylated rabbit liver glycogen has revealed that it contains two dimethyl sugars, one of which is the well-known 2 : 3 dimethyl-D-glucose (cf. ref. 2). It would thus appear that if the polysaccharide is fully methylated and if no demethylation occurs during methanolysis, at least one other linkage besides the 1 : 4 and the 1 : 6-types is present in glycogen[20]. Similar studies have also enabled us to show that the xylan of wheat straw and of corn cobs contains arabinose units in addition to those which occupy terminal positions; glucose was also identified. By making use of the fact that 2, 3, 4-trimethyl-D-xylose gives a red-brown colour and 2, 3, 5-trimethyl-L-arabinose a bluish-black colour with the *p*-amino-dimethylaniline reagent, it has also been shown that terminal xylose units as well as terminal arabinose units are present in these two so-called xylans.

These results would appear to indicate that the structure of xylan as revealed by methylation studies[13] is in need of revision. The arabinose units other than those which occupy terminal positions may arise from hitherto unrecognized building units of the xylan molecule, or from an araban-like polysaccharide which is either in admixture or in combination with the xylan molecule. The identification of terminal xylose residues, however, suggests that, in the case of xylan, we must return to the former view[21] that this polysaccharide is structurally related to cellulose and consists of long chains of xylopyranose units, joined by 1 : 4-β-linkages.

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Use of Paper Partition Chromatography in the Identification of the Volatile Fatty Acids

THE volatile fatty acids are important in many biological processes. They may be separated, identified and estimated by means of partition chromatography using silica gel columns. The whole range from acetic to capric acids, inclusive, may be separated in this way; but this involves the use of more than one solvent[1,2] (that is, separation in stages) or buffered columns[3], and several titrations.

Lugg and Overell[4] separated organic acids as the free acids on paper sheets, using a mixture of butanol and acetic acid as the mobile phase, a method inapplicable, however, to the volatile fatty acids. Fink and Fink[5] described a method in which the hydroxamates of the methyl esters of the volatile fatty acids were run on paper and developed with ferric chloride. Boldingh[6] has run the ethyl esters of the fatty acids on paper strips coated with rubber and developed the spots with Sudan IV solution.

We have successfully used the method described below for the quick identification and rough estimation of the volatile fatty acids in culture fluids and cheese distillates. This method was based primarily on the silica gel technique of Lester Smith[7] and Elsden[8], in that water was used as the stationary phase, butanol as the mobile phase and brom-cresol-green as the indicator, which was sprayed on the paper as a 2 per cent solution in alcohol after the butanol had been driven off in a current of cool air.

The free fatty acids could not be used because of volatilization during the running of the chromatogram, neither could the sodium salts, because they remained stationary. Volatile weak alkalis were tried in the hope of controlling the ionization of the acids by varying the concentration of alkali, and although this was not achieved, satisfactory chromatograms were obtained by using ammonia or ethylamine in the vapour phase.

Chromatograms so prepared remained alkaline to brom-cresol-green even after an exposure of half an hour to the atmosphere; but on a further exposure of one to several hours the blue colour of the background gradually changed to greenish-yellow, while the spots representing the acids remained blue for at least several days. Eventually they, too, faded. We have not examined the reasons for this delayed development; but acidification by atmospheric carbon dioxide at a rate depending on the buffering power of the substances in the paper seems a plausible explanation.

The volatile fatty acids do not differ greatly in strength. For example, acetic, butyric and caproic acids were found to be completely titrated with ethylamine before the pH had risen to 6. As there is an excess of the volatile alkali during chromatography and the pH is well above 6, the fatty acids in the aqueous phase will exist as anions. Thus the concentration of the alkali is not critical; if the fatty acids are neutralized (to brom-cresol-green) with ethylamine before testing, a very low concentration of the vapour may be used, with the advantage that, on spraying, the blue spots develop at once on a bright yellow background and the contrast is greater than that obtained by allowing a blue chromatogram to fade. Brom-cresol-purple can replace brom-cresol-green as developer, but the spots are less vivid. We have used ethylamine in preference to ammonia as the volatile alkali, since it gives more durable and more clearly defined spots. The spots are not permanent, but the colour contrast in the fresh chromatograms is sufficiently good to give permanent photographic records. Typical R_F values are shown in the accompanying table.

Fatty acids ($N/10$)	R_F values (room temperature)	
	Ammonia	Ethylamine
Acetic	0·11	0·20
Propionic	0·18	0·31
Butyric	0·28	0·44
Valeric	—	0·56
Caproic	0·67	0·77
Caprylic	0·81	0·91
Capric	0·84	—
Lauric	0·87	—

As with the amino-acids, the area of the spot gives a rough indication of the total quantity of fatty acid present; 4 µl. of $N/10$ solutions give convenient but rather large spots, $N/100$ is a better concentration and $N/1{,}000$ is just detectable.

Since this letter was written, a communication from F. Brown and L. P. Hall has appeared (*Nature*, July 8, p. 66) describing a method which, though similar in some respects to the one we have described, gives yellow spots on a pale blue background. Presumably, the yellow spots indicate free acids liberated by the decomposition of the ammonium salts during the heating at 95° C., primarily intended for the evaporation of the solvent. In our method the solvent is allowed to evaporate at room temperature and the ammonium or ethylamine salts do not decompose but, remaining in the water associated with the cellulose, give a solution alkaline to brom-cresol-green, and therefore appear as blue spots on the chromatogram. The loss of volatile acids is thus reduced to a minimum, and the method gives roughly quantitative results.

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Differential Phase Change at Reflexion

THE measurement of length by interferometry can only be made with the highest precision if corrections are applied for the differential phase changes produced at reflexion at the relevant surfaces. These corrections are very small, and their magnitude and relation to surface structure can best be studied by multiple-beam interferometry.

The phase change at reflexion at a surface appears to be a function of both the material and the surface finish. From measurements made on the height of steps etched in a polished glass surface, it was found that a small differential phase-change effect occurred due to the difference in surface roughness of the polished surface of the glass and the etched bottom of the step. For these measurements, the surface of the glass had been coated by vacuum evaporation with a 94 per cent reflecting layer of silver, and used as one plate of a multiple-beam interferometer.

The expressions[1] for the reflected and transmitted intensities in a multiple-beam interference system consisting of two plates, 1, 2, with reflexion coefficients R_1 and R_2 and transmission coefficients T_1 and T_2 respectively, are as follows:

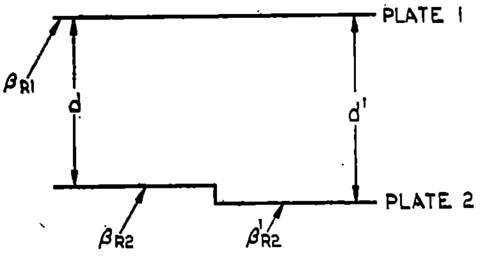
$$I_R = R_1 + \frac{T_1{}^2R_2+2R_1{}^{1/2}R_2{}^{1/2}T_1\cos(\Delta+F) - 2R_1R_2T_1\cos F}{1-2R_1{}^{1/2}R_2{}^{1/2}\cos\Delta+R_1R_2} \qquad (1)$$

$$I_T = \frac{T_1T_2}{1-2R_1{}^{1/2}R_2{}^{1/2}\cos\Delta+R_1R_2}, \qquad (2)$$

where $\Delta = \frac{4\pi d}{\lambda} - \beta_{R_1} - \beta_{R_2}$; β_{R_1}, β_{R_2} are phase changes at reflexion at surfaces 1, 2 respectively; $F = -2\beta_{T_1}$; β_{T_1} is phase change on transmission through plate 1; d is separation of plates; and λ is wave-length of light. From the conditions of maxima and minima it follows that

$$\frac{4\pi d}{\lambda} - \beta_{R_1} - \beta_{R_2} = 2n\pi + f(R_1,R_2,T_1,\beta_{T_1}) \quad \text{(reflected system)} \qquad (3)$$

and $\frac{4\pi d}{\lambda} - \beta_{R_1} - \beta_{R_2} = 2n\pi$ (transmitted system). (4)



If now one of the plates of the system is made up of two parts, as shown in the diagram, one part producing a phase change of β_{R_2} and the other of β'_{R_2}, the separation of the first part being d and of the second d', then it follows from both (3) and (4) that

$$\frac{\lambda}{4\pi}(\beta_{R_2} - \beta'_{R_2}) = (d - d') - \frac{\lambda}{2}(n - n'), \qquad (5)$$

where $(d - d')$ is true height of step in second plate; $\frac{\lambda}{2}(n - n')$ is measured value of step-height from fringes at wave-length λ; $\frac{\lambda}{4\pi}(\beta_{R_2} - \beta'_{R_2})$ is differential phase-change effect at wave-length λ. n, n' will, in general, not be integral.

If the height of the step is measured at two wave-engths, λ_1 and λ_2, it follows that

$$\frac{\lambda_1 - \lambda_2}{4\pi}(\beta_{R_2} - \beta'_{R_2}) = \frac{\lambda_2}{2}(n_2 - n'_2) - \frac{\lambda_1}{2}(n_1 - n'_1), \qquad (6)$$

vhere n_1, n'_1 and n_2, n'_2 correspond to values for λ_1 and λ_2 respectively.

Equation (6) then enables the differential phase-oss $(\beta_{R_2} - \beta'_{R_2})$ to be found from the measurement f the height of the step by multiple-beam interference ringes. Substitution in equation (5) then gives the hase-change effect at any wave-length.

This was done in the case of the etched steps in a polished glass surface, using Fizeau fringes. It was found that a change in wave-length from 4000 A. to 6000 A. produced a change in the measured height of a step of the order of 40 A. This gave a value of 14° for the differential change in phase angle, or a value of 109 A. for the differential phase-change effect at a wave-length 5461 A. As the surfaces of both the top of the glass and the bottom of the step were coated identically with a silver layer, this small differential effect could only be due to the difference between the surface structure or roughness of the etched surface and of the polished surface.

The accuracy obtained for a single height measurement was 9 A., but the overall accuracy of the determination of the phase-change effect was less than this, due to variations in etching properties of the glass from point to point. The measured change in height was therefore probably 40 A., but not greater than 80 A.

The differential phase-change effects for various metals and non-metals are now being measured by this multiple-beam interference method. Of particular interest in the measurement of length by interferometry are the phase-change effects produced with lapped surfaces of steel, chromium and glass.

This work has been carried out as part of the research programme of the Division of Metrology, Commonwealth Scientific and Industrial Research Organization.

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Deformations in the Crystal Structures of Anti-ferromagnetic Compounds

IT has been shown that slight deformations occur in the crystal structures of various oxides of the iron group. B. Ruhemann[1] has found that there is a very slight change in the crystal structure of MnO near 120° K. Rooksby[2] and Tombs and Rooksby[3] have reported that the face-centred, cubic arrangements in MnO, FeO, CoO and NiO show changes to tetragonal or rhombohedral symmetry upon cooling through a transition temperature.

The four compounds mentioned above are all known to be antiferromagnetic[4]. We should like to point out that the temperatures at which the deformations occur are apparently the antiferromagnetic Curie temperatures, as indicated by the data in the following table.

Compound	Magnetic transition temperature[4]	Structure transition temperature
MnO	122° K.	120° K. [1]
FeO	198	203 [3]
CoO	271	200–300 [3] 267–281
NiO	∼500	∼470 [3]
Cr_2O_3	311	307–18

In order to check this hypothesis further, we have made X-ray photographs of CoO and Cr_2O_3 (another antiferromagnetic compound) near their Curie temperatures. A symmetric-focusing back-reflexion camera was modified so that exposures could be taken over a temperature range of 230–350° K. The change from cubic to tetragonal symmetry reported by Tombs and Rooksby for CoO was observed. A broadening of the 331 reflexion was perceptible at 281° K. Just below the Curie temperature, at 267° K., the reflexions from the (331) and (313) planes were completely resolved.

The Curie temperature of Cr_2O_3 has been reported as 305° K. and 320° K. by different investigators[4]. Susceptibility measurements made by Dr. T. R. McGuire of this Laboratory indicate that the Curie temperature of the particular sample used here was 311 ± 2° K. The normal crystal structure class of Cr_2O_3 is D_{3d}^6. A change in structure first becomes apparent as a very slight broadening of the $4\bar{2}2$ reflexion at 318° K. At 307° K. the line is a doublet and the separation increases rapidly as the temperature is lowered.

These results can be understood qualitatively in the following way. There are two conditions necessary for antiferromagnetism. First, the crystal structure must be such that the magnetic atoms can be divided into two interpenetrating sub-lattices with atoms on sub-lattice A having nearest neighbours only on sub-lattice B, and vice versa. The exchange integral, J, between neighbouring magnetic atoms must be negative so that antiparallel spin orientations are preferred. For such conditions, the state of lowest magnetic energy is that in which all the A atoms point in one direction and all the B atoms point in the opposite direction. For any finite temperature this complete ordering will be somewhat disturbed by thermal agitation. The effective potential energy of a particular magnetic atom, due to the exchange interactions, is approximately $-2z'|J|S^2$, where z' is the net number of nearest neighbours with spins oriented antiparallel to the spin of the given atom. S is the total spin quantum number of a single atom. In general, J will be a function of interatomic separation, r. The effect of the exchange interactions, besides producing alignment, will be to move the atoms so as to increase $|J|$ and thus deepen the magnetic energy-levels. Consequently the magnetic atoms should be pulled closer together or pushed farther apart, depending on the sign of dJ/dr. Since the value of z' increases with decreasing temperature, we should expect that the deformation would also increase with decreasing temperature. Such an effect was observed by Rooksby and by us.

Arguments similar to the above have been used to explain the thermal expansion properties of ferromagnetic materials[5].

At present, we are not able to give a detailed interpretation of the crystal structure changes in terms of the exchange couplings between the magnetic atoms. When such an interpretation is available it should give valuable information concerning the exchange (and super-exchange) interactions in antiferromagnetic compounds.

This investigation was supported in part by the U.S. Office of Naval Research.

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Frictional Electrification and Gaseous Discharge

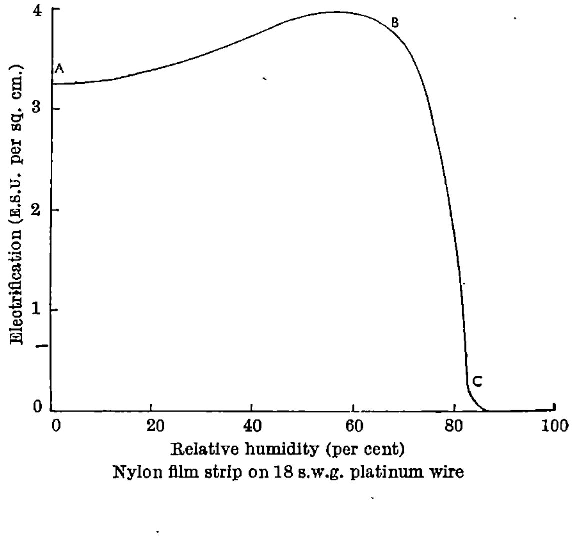
IT is well known that the leakage of charge from high-voltage static generators, such as the Van de Graaff machine, is controlled by use of high pressure or other suitable atmospheres which increase the dielectric strength of the medium in which they operate. The results reported below suggest that in a study of the mechanism of frictional electrification, quantitative measurements may be of doubtful value, because a similar leakage is apt to take place between the rubbing surfaces and to control the process of charge separation.

It has been found that the frictional electrification of some clean hygroscopic polymers is critically dependent on moisture concentration above a certain humidity. Below this humidity, or with a non-hygroscopic substance, electrification is limited by gaseous discharge between the rubbing surfaces.

The experiments which showed this effect consisted of drawing a wool fibre over a metallic cylinder (for example, a platinum wire) by means of an insulated rod, the potential generated upon the metallic cylinder being measured by a Lindemann electrometer. The apparatus was totally enclosed in a metal box, and the effects upon electrification of humidity, load, and speed of rubbing were investigated.

The quantity of charge produced per unit length of any particular fibre had an almost constant upper limit, which was not greatly dependent upon the speed of rubbing and humidity below about 70 per cent relative humidity. At higher humidity the charge fell rapidly to zero, and the electrification also became much less efficient at lower speeds. It is, however, difficult to assess accurately the actual densities of charge on fibres, and they were exchanged for strips of nylon film 5 mm. wide by 0·1 mm. thick. Results were substantially similar; a typical humidity characteristic is shown in the accompanying graph. The average charge density in the region A–B was of the order of 3 E.S.U. per sq. cm. for all rubbing speeds, loads and types of cylinder. The slope of section B–C was steeper for lower rubbing speeds.

The conductivity of wool and nylon increases rapidly and exponentially with atmospheric relative humidity[1], and it appears that above 70 per cent relative humidity the electrification is limited by conductivity through the hygroscopic polymer, which



Nylon film strip on 18 s.w.g. platinum wire then exceeds 10^{-10} ohm^{-1} cm.$^{-1}$. The enormous increase in conductivity from zero to 70 per cent relative humidity (about 10^6 times) has no apparent effect, and some other factor must control the charge generated, imposing a constant limit which corresponds to an average electric stress at the film surface of about 12,000 volts per cm., or about half the breakdown stress in air at atmospheric pressure. It is suggested that the breakdown of the air is the explanation of the limiting charge. This is supported by the fact that films of polythene, which is non-hygroscopic, could be electrified to about the same value (actually 2·6 E.S.U./sq. cm.) and showed no sharp decrease at high humidity.

Discharge between the rubbing surfaces is difficult to demonstrate directly, but the potential difference set up would depend upon the dielectric strength of the gas in the intervening space. Air saturated with carbon tetrachloride has a considerably higher dielectric strength than air alone at the same pressure[2], and it was found that the maximum charge density on nylon was increased by 50 per cent and on polythene by 100 per cent in such an atmosphere at 30 per cent relative humidity. An analogous dependence on gas pressure is to be expected, and will be investigated.

The above results refer to single, unidirectional rubs. Repeated rubbing gave somewhat higher values, but substantially the same behaviour, so that apparently a single rub is sufficient to produce local charge saturation at ordinary pressures. It seems, therefore, that a quantitative study of the mechanism of charge transfer at lower relative humidities must be conducted at high atmospheric pressures.

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Preparation of Deoxyanisoin and some Stilbenes: Reducing Action of Sodium Glycollate in Glycols

DEOXYANISOIN is prepared by reducing anisoin on heating with alcoholic stannous chloride hydrochloric acid solution[1], or tin in alcoholic hydrochloric acid solution[2], or distillation with zinc in an atmosphere of carbon dioxide[3]. It has also been prepared by heating hydroanisoin with dilute sulphuric acid[4] (the product reported by this method had a melting point of 95°, which would be 15° lower than that of pure deoxyanisoin), or with a mixture of hydrochloric and acetic acids[2]. Hydroanisoin itself is obtained by electrolytic reduction of anisaldehyde in alkaline solution using nickel, platinum[5,6] or copper[7] as cathodes, or by the action of sodium amalgam on an ethereal solution of anisoin[3], or catalytic reduction of anisil or anisoin using platinum oxide[2].

In the present work, it has been found that on efluxing anisoin[7] (10 gm.) in sodium glycollate (1·4 gm. sodium in 30 c.c. ethylene or propylene glycol) on a wire gauze for 15 min., it is readily reduced to ydroanisoin, melting point 168° (about 6·75 gm.). The latter is readily converted to deoxyanisoin (m.p. 09–110°) on distillation in vacuum in presence of ne drop of 10 per cent sulphuric acid.

On refluxing a mixture of anisaldehyde (16·8 gm.) n sodium glycollate (1·4 gm. sodium or 2·4 gm. sodium hydroxide in 30 c.c. ethylene glycol) on a wire gauze for 3½–4 hr., pure *p,p'*-dimethoxystilbene of melting point 210° (1·25 gm.), anisyl alcohol, melting point 24–25° (3·3 gm.; urethane derivative readily obtained, melting point 90–91°), anisic acid (0·16 gm.) and an unidentified product (8 gm.) which could be separated into two fractions, one of which (4·8 gm.) reduces alcoholic ammoniacal silver nitrate on heating, are obtained. The anisic acid and the corresponding quantity of anisyl alcohol (which is only a small portion of the anisyl alcohol formed in this reaction) are undoubtedly formed through Cannizzaro's reaction. Many investigators[6–11] have prepared *p,p'*-dimethoxystilbene by various methods. *p,p'*-Dibenzyloxystilbene, melting point 240° (a new compound), *p*-benzyloxybenzyl alcohol and *p*-benzyloxybenzoic acid are similarly obtained.

However, on heating anisoin (5 gm.) in alkaline glycerol (0·7 gm. finely divided sodium in 15 c.c. glycerol) in an oil bath at 190–195° for 1½ hr., anisil, melting point 133° (0·5 gm.) and showing no depression with an authentic sample, is obtained; its monoxime had a melting point of 131°. The rest of the anisoin is recovered unchanged.

The mechanism of the reactions leading to the above products will be published elsewhere.

Cannizzaro's reaction was readily carried out on heating the aldehydes (which are already known to respond to this reaction) for 2–5 min. with 2 *N* alcoholic sodium hydroxide solution (15 gm. of the aldehyde in 30 c.c. ethyl alcohol which contains 2·4 gm. sodium hydroxide; or 1·4 gm. metallic sodium previously dissolved in the alcohol); an almost theoretical yield was obtained.

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Ammodytes immaculatus, a New Species of Sand-Eel Found in European Seas

A POST-LARVAL sand-eel with a mean vertebral number of 72·0 occurs commonly in the macroplankton of the Celtic Sea and Plymouth area. Described as *Ammodytes* species IV, it was not attributable to a known adult, and the existence of another species of the family Ammodytidæ was in consequence anticipated[1]. An adult *Ammodytes* with a corresponding vertebral number has recently been identified in the Plymouth area. In appearance it is very similar to *Ammodytes lanceolatus* Lesauvage 1825, with a pair of vomerine 'teeth' in the adult and a non-protrusible upper jaw. The vertebral number of this adult and of the post-larval *Ammodytes* species IV is widely separated from that of the true *A. lanceolatus* from this and other areas.

An external character immediately distinguishing adult *A. lanceolatus* from adults of the new species is

	Vertebræ mean (range) n	Dorsal fin-rays mean (range) n	Anal fin-rays mean (range) n
A. lanceolatus			
Lesauvage		58	30
Plymouth	66·86 (66–69) 70	(55–58) 22	(28–30) 22
Irish Sea, Port Erin	66·88 (66–68) 40		
North Sea[2]	66·73 (65–69) 126	56·24 (54–58) 125	29·55 (27–31) 127
Baltic[2]	66·85 (65–69) 293	56·02 (53–59) 291	29·78 (27–32) 292
A. immaculatus			
Plymouth	71·86 (70–74) 42	60·23 (59–62) 34	32·61 (31–34) 34
Douananez[3]	72·09 (70–74) 78		

the presence in *lanceolatus* of a prominent black-spot on each side of the snout just above the middle of the upper jaw. The snout of the new species is uniformly dark. Referring to this difference of marking, the name *Ammodytes immaculatus* is proposed for the new species.

It is evident from the vertebral counts given by Forest[3] that his specimens from Douananez belong to *A. immaculatus* and not to *A. lanceolatus*. Further observations on the new species are in course of preparation.

Until recently, only two species of sand-eel were commonly known in northern European waters: *A. lanceolatus*, the greater sand-eel, and *A. tobianus*, the lesser sand-eel. In 1934, Raitt[4] described a new species, *A. marinus*, occurring very abundantly in Scottish waters, and now known to have a wide distribution in the north-eastern Atlantic. He also found *Gymnammodytes semisquamatus*, the Atlantic smooth sand-eel, to be abundant off Scotland, although previously only a single specimen had been recorded from British waters[5]. *A. immaculatus* now increases the number of north European species of Ammodytidæ to five. This is of interest in relation to Raitt's statement, based on the work of other investigators, that "Sand-eels have long been recognized to be of highest importance in the economics of the sea. They form a large proportion of the regular diet of almost all our food fishes. . . ."[4]

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A New Strain of *Leptospira* in Israel

An outbreak of an epidemic of leptospirosis began in Israel in the middle of 1949 and is still continuing. From June 1949 until April 1950, more than a thousand cases were observed in a narrowly limited district—the plain of the Sharon. Some cases were very severe, showing hæmaturia, oliguria, azotæmia, jaundice, meningitis and episcleral injection; the death-rate was 2 per cent. Most of the sera of the patients agglutinated *Leptospira grippo-typhosa* and *Leptospira bovis*, the titres ranging from 1 : 200 to 1 : 20,000.

The course of the epidemic did not correspond to that caused by *Leptospira bovis*, which was described by Bernkopf *et al.* in 1947[1]. According to these authors, cattle infected with *Leptospira bovis* caused the epidemic of 1946–47, which affected mainly butchers, veterinarians and other persons handling infected meat. For the following reasons, the present epidemic must be ascribed to another source: its intensity and suddenness; its appearance in a limited area only, whereas infected cattle were found throughout the country without causing leptospirosis elsewhere; the appearance of the disease in settlements having healthy cattle or no cattle at all; and the statistically established fact that most of the patients were growers of vegetables.

Simultaneously with the outbreak, there was a distinct rise in the rodent population of the country, and a relation to the epidemic was suspected. Various rodents (*Rattus norvegicus*, *Mus musculus*, *Meriones tamaricinus* and *Microtus guentheri*), caught in the area of the epidemic, were examined for *Leptospira* and corresponding antibodies. Cultures were made on Schueffner's medium from the urine, kidneys, liver and blood, and dark-field examinations were carried out with the urine and kidneys. Furthermore, agglutination tests were made, with *L. grippo-typhosa*, *L. bovis* and a *Leptospira* isolated by us from the blood of a patient of the present epidemic. Absorption tests showed that serologically this last strain was related to *L. grippo-typhosa* and *bovis*, but not identical with either of them.

No leptospiras or their specific antibodies were found in mice and rats. Sera of 70 per cent of the voles caught in the infected area showed agglutinating titres between 1 : 200 and 1 : 3,000 against the three strains; leptospiras were found upon dark-field examination of their kidneys and were cultivated on Schueffner's medium. Neither antibodies nor leptospiras were found in voles caught in non-infested areas.

Leptospira-free voles, bred in the laboratory for several years, were infected by intraperitoneal injection of leptospira isolated from a human case. They appeared in the kidneys after eight days, and were excreted with the urine in large quantities although the animals showed no outward signs of illness. Three-weeks-old albino mice infected in the same way showed leptospiras in the blood during the first four days after injection. From the fifth day onwards, leptospiras could no longer be found in the blood but appeared in the kidneys, and from the sixth or seventh day onwards they were excreted in the urine in very large numbers, at least ninety-nine days after the infection.

This method is now being used for the isolation of leptospiras and the diagnosis of leptospirosis: blood taken from patients during the first five days of illness gave negative results on Schueffner's medium, but mice infected with it excreted leptospiras in the urine two to five days after the infection.

As neither *L. grippo-typhosa* nor *L. bovis* can be found in the urine of the mice following an intraperitoneal injection, it has now become possible to differentiate the new strain from them.

The etiology of the present epidemic has thus become clear. A new strain of leptospira is transmitted by a native vole (*Microtus guentheri*) which lives in a region characterized by heavy soils, excretes with its urine leptospiras in vegetable plantations and causes an infection of gardeners and agricultural workers.

E. Olejnik
S. Shneyerson

Department of Bacteriology,
Hadassah Medical School,
Hebrew University,
Jerusalem.
April 4.

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[1] Bernkopf, H., Olitzki, H. L., and Stuczynski, A., *J. Inf. Dis.*, **80**, 5 (1947).

Elimination of Kappa Particles from 'Killer' Strains of *Paramecium aurelia* by Treatment with Chloromycetin

CERTAIN strains of *Paramecium*, known as 'killers', contain in their cytoplasm particles, called 'kappa particles'[1], which are Feulgen-positive, and stain with Giemsa after acid hydrolysis[2]. Killers liberate into the culture medium a substance lethal to *Paramecium* not containing kappa particles, known as 'sensitives'. Kappa particles have many of the properties of cytoplasmic genes[3], but their size (0·2–0·5 μ in length), and their staining reactions, suggest that they may be parasitic micro-organisms[2-5] such as the rickettsiæ, viruses of the psittacosis-lymphogranuloma group, or even small bacteria.

In an attempt to decide between these two possibilities, killer *Paramecium aurelia*, stock *H*, was cultured in baked lettuce infusion which had been inoculated with *Bacterium aerogenes* containing 2 mgm. chloromycetin per c.c. The chloromycetin did not affect the culture density of *Paramecium*, but after nine to fourteen days it was impossible to demonstrate any kappa particles in the *Paramecium*, when stained with Giemsa after acid hydrolysis. These killers, after chloromycetin treatment, had also lost their capacity to kill *P* stock sensitives.

Chloromycetin is an antibiotic active against certain bacteria, rickettsiæ, and viruses of the psittacosis-lymphogranuloma group, and the above result is further evidence for classing kappa particles with these parasitic micro-organisms; but as another antibiotic, streptomycin, has recently been found to eliminate the chromatophores in *Euglena*[6], and in seedlings of higher plants[7,8] the reaction of kappa particles to chloromycetin is not conclusive evidence for their parasitic nature.

Miss R. T. Gilmartin, of the Osborn Zoological Laboratory, Yale University, has treated stock *51* killer *Paramecium* for up to seventy-two hours with concentrations of chloromycetin ranging from 0·02 to 1·25 mgm. per c.c. Under these conditions, the number of kappa particles per animal was reduced, but they were not completely eliminated[9].

Cultures of *Paramecium* for this work were kindly supplied by Dr. J. R. Preer, of the University of Pennsylvania.

C. H. BROWN

Department of Cancer Research,
London Hospital, E.1. June 1.

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[1] Sonneborn, T. M., *Proc. U.S. Nat. Acad. Sci.*, **29**, 329 (1943); *Amer. Nat.*, **79**, 318 (1945).

[2] Preer, J. R., *Amer. Nat.*, **82**, 35 (1948); *Genetics* (in the press).

[3] Sonneborn, T. M., *Ann. Mo. Bot. Gard.*, **32**, 213 (1945); Cold Spring Harbor Symposium on Quantitative Biology, **11**, 236 (1946).

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[7] Euler, H. von, *Arkiv. klin., Min., Geol.*, **25a**, 1 (1948).

[8] Bracco, M., and Euler, H. von, *Klin. Arb.*, ii, **10**, 1 (1948).

[9] Gilmartin, R. T. (personal communication).

Strength and Fatigue

IT is generally thought that the very large forces which isolated muscles can develop when excited electrically would produce movements so violent as so endanger tendons and bones if they were available n voluntary contractions in normal life. Our strength s kept within bounds by the inability of the higher centres to activate the muscles to the full. In a prolonged effort, this limited capacity to drive anterior horn cells by an effort of will is the part of the neuromuscular apparatus most subject to fatigue, so that the observed falling off in performance is due to an even less complete nervous activation of the muscle fibres rather than to failure of the contractile mechanism itself[1,2].

Against these views stands a simple observation. A subject lays his arm on a table with his hand over its edge and palm upwards. The forearm muscles are exercised by repeatedly flexing the wrist against the resistance of a 10-kgm. weight held by a cord loop in the hand. At first it is easy to make a movement of full range, but after some fifty repetitions the wrist can only be half-flexed. Exercise is then stopped and at the same time the circulation to the forearm is arrested by inflating a blood-pressure cuff on the upper arm. Test movements made every minute show that muscular power does not recover so long as the cuff is kept on (up to five minutes), but returns to normal within one minute when it is released, whatever the interval after imposition. Circulatory arrest alone causes negligible diminution in muscle strength until ischæmic paralysis supervenes in about thirty minutes. The only straightforward interpretation of this experiment is that fatigue in this type of exertion is peripheral. Reid[3], however, avoided this conclusion in a somewhat similar experiment by supposing that inhibitory afferent impulses are set up in the forearm "protective against excessive prolongation of activity and undue development of fatigue processes in muscle", and this was apparently confirmed by observing that good contractions were maintained to electrical stimulation of the median nerve.

Such suggestions can only be refuted by a more elaborate quantitative investigation. For this purpose the adductor pollicis is a better muscle, for (with suitable experimental arrangements to prevent interference) it is the only muscle employed in voluntary adduction of the thumb and it can easily be stimulated electrically through the ulnar nerve without involving other thenar muscles. Voluntary and artificial contractions, therefore, occur in exactly the same muscle and can be validly compared. In this way it has been shown that: (1) the tensions developed by a strong voluntary effort and by a maximal motor nerve tetanus are closely the same; (2) both tensions decline equally during fatigue and remain the same during a subsequent period of circulatory arrest; (3) the muscle action potentials to nerve stimulation do not significantly alter, indicating that neuromuscular block does not develop. (Fatigue was not carried beyond a 50 per cent reduction of muscle strength.) Voluntary effort, then, can call up the full potential power of the muscle; fatigue is due to failure of the contractile mechanism itself and not to nervous factors. Presumably the same metabolic causes in the muscle underlie the fatigue of small voluntary movements, as have long been known from the work of A. V. Hill to limit severe exertions of the body as a whole.

P. A. MERTON
G. PAMPIGLIONE

Medical Research Council
Neurological Research Unit,
National Hospital, Queen Square,
London, W.C.1. May 19.

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[1] Starling, E. H., "Principles of Human Physiology" (London, 1941).

[2] Bartley, S. H., and Chute, E., "Fatigue and Impairment in Man" (New York, 1947).

[3] Reid, C., *Quart. J. Exp. Physiol.*, **19**, 17 (1928).

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, September 25

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the Franklin Gardens Hotel, Northampton), at 7 p.m.—Mr. A. P. Young: "Industrial Management and its Human and Social Implications".*

(To be given on Friday, October 6, at 7.30 p.m., at the Mechanics Institute, Burton Street, Nottingham, and on Tuesday, March 13, 1951, at 7 p.m., at the Preston and District Building Trades Employers' Association, Starkie House, Starkie Street, Preston.)

Monday, September 25—Thursday, September 28

FARADAY SOCIETY (in the Department of Zoology, The University, Cambridge).—General Discussion on "Spectroscopy and Molecular Structure and Optical Methods of Investigating Cell Structure".

Tuesday, September 26

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. P. H. Cook: "An Examination of the Notion of Communication in Industry".

PLASTICS INSTITUTE, LONDON SECTION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Dr. R. G. Heyes: "The Chemical Industry and Plastics". (Members of the Plastics and Polymer Group of the Society of Chemical Industry are invited.)

Wednesday, September 27

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—25th Annual General Meeting; at 7.15 p.m.—Mr. Paul Adorian: Presidential Address.

Wednesday, September 27—Friday, September 29

NATIONAL SMOKE ABATEMENT SOCIETY (at Margate).—Annual Conference; Dr. D. T. A. Townend: First Des Voeux Memorial Lecture.

Thursday, September 28

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. W. Mohrman: "Elastic and Viscous Properties of Polystyrene in Solid and Liquid States".

Friday, September 29

FARADAY SOCIETY, COLLOID AND BIOPHYSICS COMMITTEE (in the Chemistry Department, The University, Manchester), at 10 a.m.—Informal Conference on "The Electrical Double Layer".

PHYSICAL SOCIETY (in the Physics Theatre, Birkbeck College, Breams Buildings, London, E.C.4), at 5 p.m.—Symposium on "Cosmic Rays".

Friday, September 29—Sunday, October 1

ROYAL STATISTICAL SOCIETY (at The University, Sheffield).—Conference on "Scientific Method in Industrial Production".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMISTS (Experimental Officer grade) at Ministry of Supply factories in South Wales and South-West England, for experimental work connected with the manufacture of explosives and acids and routine analysis of a more intricate nature—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.541/50A (September 30).

FORESTERS in the Forestry Department of the Division of Agriculture and Lands—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (September 30).

GENERAL ASSISTANT ENGINEER in the Electro-Technical Research Section of the Research Branch in London—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting A.E.91 (September 30).

RESEARCH POST IN EXPERIMENTAL PATHOLOGY—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (September 30).

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (September 30).

SENIOR BIOCHEMIST in charge of the Endocrine Laboratory at Chelsea Hospital for Women—The Secretary, Queen Charlotte's and Chelsea Hospitals, 339 Goldhawk Road, London, W.6 (September 30).

TEACHER IN MATHEMATICS—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (September 30).

UNIVERSITY GRADUATE with first- or second-class honours in botany, preferably with postgraduate experience in ecology, to undertake a comprehensive survey of heather moors with special reference to methods of management in relation to grazing value—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (September 30).

CHEMISTS as Senior Assistants (Scientific) at factories in South Wales and Southern Scotland to supervise Assistants (Scientific) engaged on routine chemical analysis and to carry out routine chemical analysis without immediate supervision—The Ministry of Supply, Est. 3 (C) 1, Room 828, John Adam Street, London, W.C.2, quoting No. V.R.498 (October 4).

ORGANIC CHEMIST for the Plant Protective Chemistry Section, to work on problems of chemical control of pests and diseases of fruit and hops—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (October 7).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Secretary and Registrar, University College of North Wales, Bangor (October 10).

ELECTRONIC ENGINEERS and PHYSICISTS (Experimental Officer grade) at Ministry of Supply Research and Development Establishments in the South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.253/50A (October 10).

BRITISH JUTE TRADE RESEARCH ASSOCIATION'S RESEARCH GRANT for investigations by X-ray analysis and other methods into the fundamental structure and properties of fibres with particular reference to jute—The Secretary, University College, Dundee (October 14).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY—The Secretary, University College, Southampton (October 14).

SCIENTIST, Grade III (with a good honours degree in chemistry), in the Board's Coal Survey Laboratory at Chester—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/255 (October 14).

DIRECTOR OF THE INSTITUTE—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (October 16).

ANALYST to take charge of the Chemical Laboratory connected with Crop Testing—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ANALYTICAL CHEMIST (with an honours degree and some industrial experience)—The Superintendent of Laboratories, British Scientific Instrument Research Association, Sira, Southill, Elmstead Woods, Chislehurst, Kent.

ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments, and divided between (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects, (*d*) miscellaneous (including Library and Technical Information services)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068.

ASSISTANT MECHANICAL and ELECTRICAL ENGINEERS in the Directorate General of Works, which is responsible for the design, operation and maintenance of all ground mechanical and electrical works service on R.A.F. and Civil Aviation Stations at home and overseas—The Under-Secretary of State, Air Ministry, S.2(h), Cornwall House, Stamford Street, London, S.E.1.

BANANA RESEARCH OFFICER in Jamaica—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/260.

CIVIL ENGINEER, to be responsible for the design, layout and construction of ancillary buildings for large chemical factories—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

DIRECTOR OF THE SIR ALFRED JONES LABORATORY (to be used as a research station for tropical diseases) at Freetown, Sierra Leone—The Under-Secretary of State, Colonial Office (Research Department) Sanctuary Buildings, Great Smith Street, London, S.W.1.

INSPECTORS OF AGRICULTURE (with a sound training in practica agriculture and a university degree or college diploma in agricultur or equivalent academic qualifications) in the Sudan—The Suda Agent in London, Wellington House, Buckingham Gate, London S.W.1, endorsed 'Inspector of Agriculture'.

JUNIOR SCIENTIFIC OFFICER (with a degree in general science pharmacy or biology), for technical work in the Blood Transfusio Service Laboratories—The Regional Transfusion Officer, Roya Infirmary, Manchester 13.

OFFICER-IN-CHARGE, Camden Park Experimental Station (Agricultural), by the Government of St. Vincent, Windward Islands—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 quoting M/N/23443 (3F).

PRINCIPAL SCIENTIFIC OFFICER-IN-CHARGE of the Freshwate Fisheries Research Station, to be established at Fort Rosebery Northern Rhodesia—The Under-Secretary of State, Colonial Offic (Research Department), Sanctuary Buildings, Great Smith Street London, S.W.1.

PROFESSIONAL ENGINEERS in many departments of the Civil Servic for a wide variety of engineering duties—The Secretary, Civil Servic Commission, Trinidad House, Old Burlington Street, London, W.1 quoting No. 3225.

RESEARCH OFFICER (Senior Scientific Officer), East African Agriculture and Forestry Research Organisation, to take charge of th chemical analytical laboratory—The Under-Secretary of State Colonial Office (Research Department), Sanctuary Buildings, Grea Smith Street, London, S.W.1.

SURVEYORS to carry out topographical and cadastral surveys i Malaya—The Director of Recruitment (Colonial Service), Colonia Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 quoting No. 27076/28.

TECHNICAL OFFICER, for work mainly concerned with technica and administrative questions received from member firms and associations in connexion with the treatment and disposal of trade effluents—The Technical Director, Federation of British Industries, 2 Tothill Street, London, S.W.1.

WORKS ENGINEER at Capenhurst Factory, Chester, to be responsibl for all factory engineering services—The Ministry of Supply, Divisio of Atomic Energy (Production), Risley, Warrington, Lancs.

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DEARTH OF SCIENCE TEACHERS IN SCHOOLS

AT the Birmingham meeting of the British Association for the Advancement of Science, a special evening meeting was arranged by the Division for Social and International Relations of Science to discuss the question of the shortage of science teachers. The importance and urgency of this problem was amply demonstrated by the numbers attending, despite other attractions arranged for the same evening. This matter was raised in January last at a meeting of the Division, when it was agreed that, since the shortage is one which clearly threatens to reduce the output of scientific workers to a level which may have serious results for the nation, a sub-committee be appointed: its job was to prepare information concerning the dearth of science teachers, and this information was set out in a document for discussion at Birmingham.

It is well to be quite clear about the purpose of the discussion. Even a preliminary study of the problem is sufficient to show its complications and difficulties. How, for example, can the shortage of science teachers be separated from the shortage of other teachers ? How does one separate science graduates from graduates in arts ? Not always is there a clear, sharp line between the two: indeed, there are occasions when they are indistinguishable. We are glad to note that the sub-committee's document did not avoid that issue, and that it showed the danger of doing something hurriedly which might so easily militate against doing something of lasting value. With that in mind, the chairman of the sub-committee, Mr. Ritchie Calder, who was also chairman of the meeting at Birmingham, made clear that there was no intention of passing resolutions and making specific pronouncements at this stage. The object of the discussion, he pointed out, was two-fold: it was to focus attention on the shortage, and to gather further suggestions which might help the sub-committee and the British Association if it were found possible to recommend specific action.

There can be no doubt about the shortage. Irrefutable evidence exists in technical colleges, grammar and modern schools; it has been set out in reports of university appointments committees, in the published results of inquiries, and in the document discussed at Birmingham. The important questions to be examined, therefore, are: What are the causes of the shortage, and what can be done about them ?

Both these questions were dealt with in the document before the Birmingham meeting and in the discussion itself. As to causes, it is clear that the salary paid to science teachers is insufficient when there is competition for people trained in science between the teaching profession, industry and government departments. This has been made abundantly clear in correspondence in professional and other journals, and should be taken fully into account by the Burnham committees which are at present negotiating new salary scales for teachers in Great

Britain. Other causes may well be found in the immobility of the teaching profession, which is a result of housing shortage, and in the conditions and prospects of science teachers. In this connexion, reference was made by the sub-committee, in preparing material for the Birmingham discussion, to the appointment of science teachers to headships and directorships of education; it would be interesting to know how many such appointments are secured by science teachers as compared with arts teachers, for whom these posts seem traditionally to be reserved.

But there is, of course, a cause perhaps even more potent than all these. Everyone knows that, before the War, advertisements attracted large numbers of applicants, not only in the teaching profession, but also in many other spheres of employment. Now the response is small, and sometimes, indeed, non-existent. With this in mind, the sub-committee was right in emphasizing the point that in the pre-War years we lived under a contracting economy which was accompanied by unemployment. The opposite is now the case. We live under an expanding economy which is accompanied by man-power shortage. Nor would it be wise to assume that the man-power problem is merely a very temporary phase. Further, since science graduates are so much in demand in schools, in industry and in government departments, it seems inevitable that close attention must be given to the spread of available scientific workers so that the demand in all these fields may be satisfied as equitably as possible. That may mean that the teaching profession will not be able to look forward with any high confidence to recruiting so large a proportion of graduates with high honours in science as it did in times of a contracting economy. This is by no means palatable, since the teaching profession ought to recruit the best; nevertheless, it is a matter which must be faced and examined.

All these points were before the meeting at Birmingham, when the discussion was opened by Sir Fred Clarke, formerly professor of education and director of the Institute of Education, University of London, Sir Arthur Fleming, director and manager, Research and Education Department, Metropolitan-Vickers Electrical Co., Ltd., and Dr. A. W. Barton, headmaster-elect of the City of London School. The last-named, as a headmaster, had no difficulty in showing how acute the shortage of science teachers is and how far-reaching its effects may be. Sir Fred Clarke, too, showed that there is no doubt about the shortage, but he suggested that the problem, with all the careful approach it needs, could not be solved by immediate sweeping change. In his usual lucid and thoughtful way, he argued for a short- and a long-term policy. Particularly he showed the dangers of approaching the salary question merely from the angle of shortages. If that were done, he indicated other ranges of the teaching profession where shortages were acute, and showed that hurried adjustments to remedy those shortages might go far towards the destruction of salary structure.

A great deal of weight has often been placed upon the advantages which accrue to science graduates who go over to industry; but it was here that Sir Arthur Fleming, out of his long experience, was able to be more precise than is sometimes the case when this matter is discussed. Salaries are, of course, attractive, he said, when the science graduate has proved his worth; but they are not necessarily attractive before that has been done. Moreover, compared with those in the teaching profession, holidays are short and security of tenure such as exists in the teaching profession does not exist.

The fruitfulness of the discussion will depend on the way it is followed up. It is hoped that contributors to it will forward not only the suggestions they then made, but also any new evidence and ideas, so that a decision may be reached as to any action which the Association can finally take to solve this urgent and vital problem. The Association has done well to provide a platform for focusing attention on the subject, and is giving a valuable demonstration of the fundamentals of scientific method in its careful approach.

THE PHILOSOPHY OF BOTANY

The Natural Philosophy of Plant Form

By Dr. Agnes Arber. Pp. xiv+247. (Cambridge: At the University Press, 1950.) 25*s.* net.

DR. AGNES ARBER has long been held in high esteem among botanists for her books on plant morphology and on the history of botany, which have been models of careful investigation, clear thinking, lucid expression and admirable illustration. She has now given us one of the most important botanical works of the present century, which few students or teachers of the plant sciences can afford to neglect. Everyone concerned with the study o plants holds some view as to the relationship of their parts and structures; but the philosophical basis of such views is seldom realized. Few, if any, British authors for more than a century have discussed the fundamental concepts and the mode of reasoning which have led men to generalizations on plant-form and confusion of thought on these matters has been widespread. This confusion has arisen through the persistent attempts, made during the past eighty years, to blend the pre-Darwinian philosophy o plant-form, a purely intellectual concept, with the materialistic and objective outlook of the doctrine of evolution. Describing the source of this error Dr. Arber writes, "by a feat of legerdemain, which seems to have passed almost unnoticed, the Ancestral Plant was substituted for the Archetypa Plant, and those characters which had, with reason been attributed to the mental conception of the archetype, were, without further justification assumed to have been proven for an actual, historically existent ancestor". The results of this fallacy have become so deeply embedded in the minds of many botanists of the present day that they often fail to understand both the achievements and merit of the old or classical morphology, and also the logical position of those who are trying to provid an interpretation of plant-form from the point o view of evolution. It is seldom realized that we know nothing about the ancestors of the angiosperms, and have no objective information relating to the structure of their flowers. Most of the dis cussions of floral evolution are therefore entirely fictitious.

The present work places the long and valuable study of plant form in its true perspective. The doctrine of evolution finds little or no place in the author's development of her subject. "To arrive at the fullest understanding of any individual plant form, we have," she says, "first to realize it accurately by means of sensuous perception, secondly, to get the completest possible picture of it with the mind's eye . . . and thirdly, to advance beyond this representation so as to grasp its underlying and surrounding context of significance, and to see it in its living aspect and in its relation to other forms." Believing that repeated scrutiny of the embryonic phases of biology is essential to its progress, she traces the origin and development of morphological thought from the time of Aristotle to the present day. The comparative study of plant-form requires a frame of reference in terms of which the manifold varieties of shape and structure may be described and classified. The required standard of comparison is provided by the concept of the organisation type.

The development of this concept by Goethe and others is explained, and Dr. Arber shows that, to Goethe, the *Urpflanze* was a mental concept, which carried no phylogenetic implications, and did not suggest any notion of an ancestral stock. This archetype was visualized as an axis bearing a series of lateral appendages of varying form, but all referable to an abstract concept which was called the leaf (*Blatt*), but for which the term phyllome is preferable. The axis bore one (or more) roots. The phyllome varies so much in form in the cotyledons, bud-scales, foliage leaves, bracts and the parts of the flower, that morphologists, while generally regarding it as an easily recognized category, have not attempted to define it. In her treatment of the concept of leaf organisation, Mrs. Arber makes a very important new advance by the development of the thesis that the leaf is to be regarded as a partial shoot, with an urge towards whole shoot characters. "The different kinds of phyllomes are not regarded as manifestations of, or deviations from, one type, but are treated as parallel members, whose characteristics depend upon the fact that they are all incomplete shoots." Much interesting evidence, illustrated by figures, is brought forward in support of this view, and a modification of her well-known theory of the nature of the leaf in many monocotyledons is proposed. It is interesting to find that this new concept of the leaf closely resembles the views that have been developed in the 'new morphology', based on evolutionary evidence.

The new interpretation of the phyllome, or leaf, simplifies the morphological treatment of repetitive growth, such as is seen in compound leaves; it leads to the concept of parallelism in organisation and configuration between different phases of the plant body. The development of this idea, as applied to inflorescences and flowers, provides a mode of approach, simpler and more satisfactory than that of Troll, to the reproductive branches of plants like the Compositæ and Umbelliferæ. Wilhelm Troll, as a rigid typologist, had to face considerable difficulties in dealing with structures in which an inflorescence of inflorescences has the general form of a single flower, and those who were not well trained in metaphysics found his *Gestalt* theory very difficult to comprehend. Many readers will be grateful to Dr. Arber for her explanation and illustration of Troll's views.

The concluding chapter, on the interpretation of plant morphology, is of particular interest, for it illustrates very clearly the author's approach to her subject and its difference from the materialistic point of view common among botanists to-day. Starting from Aristotle's investigation of the nature of causation, she examines the relationship between the mechanistic and teleological interpretations of structure. "We can free ourselves," she remarks, "from the crippling effects of the antithesis between teleology and mechanism, by recognizing that they are not inherently antagonistic but that they represent the organism *under two different attributes*—the physico-chemical attribute, and the attribute of inherent directiveness."

It is difficult to give an adequate account of Dr. Arber's philosophy and of her treatment of the work of other thinkers. She helps her readers to follow the argument by the provision of many excellent figures; but, nevertheless, many botanists will find themselves in an unfamiliar world of thought. They may have been interested in experimental morphology, or in other studies of plant-form, which have originated in the idea of evolution. Such considerations, however, belong to a materialistic philosophy, which does not enter into the system of ideas developed by the author.

When the significance of the concepts of the classical morphology have been understood, the reader will be better prepared to consider alternative methods of thinking about plant-form. For example, many of the differences in the shape and structure of plants may have come about through the operation of internal and external factors on a race of organisms in the course of many generations. The relationship between the resulting forms, though originally envisaged as a concept, is an objective connexion, entirely independent of the exercise of man's mental powers. This connexion is demonstrated by the methods of the historian rather than by those of the philosopher.

From this point of view it may be possible to establish a new frame of reference for the study of form, based on a knowledge of the changes that have occurred during past ages. Such a frame of reference seems to be a valid alternative to that founded on the intellectual concept of the ideal plant. Its construction and use involve not only the consideration of the geological records, but also the study of all the biological factors affecting the life and growth of plants.

While some progress has been made in the formulation of this new morphology, it is still incomplete. But even when developed into a philosophic system, it will not invalidate the work of those who have followed the classical tradition. An analogy may make this clear. A comparative study of the great cities of the world may be made by comparing each of them with the plan of an ideal city, as conceived in the mind. An alternative method would be to trace and compare the way in which each has grown from a primitive settlement. The two methods constitute distinct modes of approach to the same problem. It would be a mistake to suppose that Dr. Arber's treatment of plant-form is diminished in value because of its abstract character. It will be long before any materialistic or new system is produced which is comparable with the body of thought that Mrs. Arber has now put before us.

H. Hamshaw Thomas

FOR THE UNDERSTANDING OF SCIENCE

The Growth of Scientific Ideas

By Dr. William P. D. Wightman. Pp. xii+495+8 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 25*s*. net.

THIS is an important and valuable work, and its purpose is well outlined in the preface. Dr. W. P. D. Wightman, referring to two great thinkers of the recent past—R. G. Collingwood and A. N. Whitehead—writes: "In their several ways they have, I believe, emphasised the two-fold nature of historical fact, namely, that every standpoint is what it is by virtue of its origin from the past and its urge towards the future". This consciousness of the importance of evolution in a context of associated ideas, which runs through the book, places it in a special position among the various histories of science. It is a guide to the study of the development of scientific thought as illustrated by a few dominant ideas. In consequence, the author is at great pains to reveal problems as they appeared to leading thinkers of each age, "to describe in outline the nature of the solutions attempted, and to assess (in the light of later modification) the proportion of essential truth to psychological imagery . . . In this way, science becomes revealed as a *struggle*, a struggle no less charged with humanistic value than the struggle for political liberty or national expression; in a word, as a branch of *Litteræ Humaniores*." A great merit in the method of treatment is the frequency of quotations from appropriate original sources, whereby a sense of historical actuality may be acquired by such controversies as phlogiston, caloric or animal spirits.

At the outset the author emphasizes the importance of recognizing the dependence of Greece on earlier civilizations—"we are in no doubt that *science* was born with infinite pains and in many places, neither by the happy inspiration of one man, nor at any clearly defined epoch". Greek thought, however, differed from all that had gone before in both generality and rigour. "Science is, among other things, the generalization of perceptual experience by means of adequate concepts; the concepts grow with the experience; history is the record of their growth: philosophy, among other things, the critique of their adequacy." The first chapter, "The Birth of Scientific Ideas", from which these quotations are taken, forms a comprehensive prologue to the whole book.

Dr. Wightman has quite naturally divided his work into two parts—"Matter and Motion" and "Nature and Life". The first part (which contains twenty-four of the total thirty-three chapters) deals with the scientific ideas leading up to the Copernican Revolution and later the Newtonian, and ends with a masterly survey of the power of physical analysis. The second part leads to the Darwinian Revolution, and the final paragraph is an indication of the author's faith—"'In my end is my beginning'. In the growth of ideas these words are charged with a new ambiguity; for, if the history of science teaches us anything, it is that only to those who ask the right questions are any answers vouchsafed. Not even to them are these answers the end of the quest, but only an enlargement and a refining of the question. If we look back to see whence we have come, we may better set the course on which we are to go. And in frequent converse with those who have brought us where we are, we enjoy in Whitehead's immortal words 'the habitual vision of greatness', without which the Conquest of Nature must spell the Defeat of Man."

The illustrations are well chosen and well produced, and the value of the work is enhanced by a list of sources at appropriate intervals throughout as well as a general bibliography at the end. A short "Chronology" and a separate name and a subject index are in keeping with the author's characteristic attention to detail.

THE SCIENCE OF METALS

Progress in Metal Physics

Edited by Dr. Bruce Chalmers. Vol. 1. Pp. viii+401. (London: Butterworth's Scientific Publications, Ltd.; New York: Interscience Publishers, Inc., 1949.) 45*s*. net.

"THE purpose of this volume, which is to be the first of an annual series, is to present authoritative reviews of the present state of knowledge in specialized aspects of the field that includes both physical metallurgy and metal physics." The need for a publication of this kind has long been apparent, and the editor and publisher are to be congratulated on taking a step which has been discussed and shirked by many bodies. The decision to make the book a series of reviews, and not a mere list of abstracts, is to be commended, and the result is a volume which will be of great value to all those concerned with the science of metals. The book is well produced, with pleasantly large type and clear diagrams; but the printers should obtain a proper fount of Greek characters.

The first review, by G. V. Raynor, on "Progress in the Theory of Alloys", is clear and well written, and covers a wide field rather uncritically. It is unfortunate that the author should use the symbol k for the wave number $1/\lambda$, when nearly all books use this symbol for the quantity $2\pi/\lambda$, while the statement at the top of p. 25, which identifies the direction of motion of the electron with that of the wave-number, is incorrect for electrons in periodic fields. The author also fails to point out that the high co-ordination numbers which certain authors claim for some intermetallic compounds result entirely from including neighbours at different distances, and that if comparison is to be made with normal metals the same policy must be adopted, in which case the co-ordination number for the body-centred cubic structure is $8+6=14$.

The review by A. H. Cottrell on "Theory of Dislocations" is sound, but could be made more interesting. Some readers will, perhaps, be left with the impression that the theory of dislocations is being developed too much by arbitrary assumption, when the real need is for direct experimental evidence of the underlying idea. The review by R. King and B. Chalmers on "Crystal Boundaries" is an interesting and suggestive study of a subject of great importance. G. C. Smith's review of "Age-Hardening of Metals" is less satisfactory; it could well be reduced to one-half of its present length, and most readers will be compelled to prepare their own summaries before the subject-matter is appreciated. The papers by E. H. Bucknell and W. Stevens on "Hardening Response of Steels", and by T. Ll. Richards on "Preferred Orientations in Non-Ferrous Metals", are interesting, but would both profit by the inclusion of diagrams to show the atomic processes involved. It is significant to notice how, in comparing the effects of different elements in steel, little or no attention is paid to the atomic as contrasted with the weight percentages of the added elements. The final review, by A. D. Le Claire on "Diffusion of Metals in Metals", deals with a subject of extreme importance, which has been rather neglected in Great Britain. The volume thus covers a wide range and will interest many readers.

W. HUME-ROTHERY

THE FISCHER-TROPSCH PROCESS

The Technology of the Fischer–Tropsch Process

By B. H. Weil and J. C. Lane. Pp. xiii+248. (London: Constable and Co., Ltd., 1949.) 22*s.* 6*d.* net.

Die Kohlenwasserstoff-Synthese nach Fischer–Tropsch

Von Dr. Franz Kainer. Pp. vii+322. (Berlin, Göttingen und Heidelberg: Springer-Verlag, 1950.) 39.60 D. marks.

THE technical feasibility of converting coal into liquid fuels, that is, aviation spirit and diesel oils, by the Fischer–Tropsch process, in which a mixture of carbon monoxide and hydrogen prepared from coke and steam is converted catalytically at low pressure into mixtures of hydrocarbons and oxygenated products, has already been demonstrated in Europe. The Fischer–Tropsch process was put into commercial operation in Germany in 1936, and underwent a rapid development during the Second World War when Fischer–Tropsch products were used for eking out deficiencies of chemical materials of natural origin other than liquid fuels.

At the present time intensive research on many aspects of the Fischer–Tropsch process is being pursued in the United States, and the construction of several commercial plants has been projected. In the book by B. H. Weil and J. C. Lane, the American authors have reduced to coherence some three thousand articles, reports and patents on the Fischer–Tropsch process. The work contains twenty chapters, each with a bibliography, and three appendixes. The first five chapters deal with synthesis gas, its preparation from coal and from natural gas, and its purification from sulphur compounds. Four chapters are devoted to reaction mechanisms and catalysts and are followed by seven further chapters on the main products (gaseous fuels, gasoline, diesel oil, waxes, lubricants) and the by-products (fatty acids, soaps and detergents, alcohols, etc.). The concluding four chapters on the economics of the process in the United States will be of less interest to non-American readers. The three appendixes containing extensive and classified lists of patents, government-released reports and recent rticles and papers (to 1946) constitute an extremely useful directory to original sources of nformation. This book can be recommended as an xcellent introduction to the subject for the general eader, and as a reference text for anyone actively working in the field.

The second book, by F. Kainer, covers much the ame ground with the difference of emphasis which would be expected from a German author. While he text contains more information drawn from riginal sources in patents and journals than Weil and Lane have thought fit to include, it is an ill-digested production, and appears to have been put together hastily from a none-too-complete card-index bibliography of the subject. The author does not seem to have had access to B.I.O.S., C.I.O.S. and similar reports on aspects of German Fischer–Tropsch technology, which contain a vast amount of important matter. Numerous obvious errors have occurred in transcription, especially in the names of British workers.

This treatise is a poor example of a familiar type of compilation. To make a book of this kind, a kind which has a real, if limited, use, requires little critical ability. The user only expects that the bibliographical references to original sources will allow him to assemble for himself the information he needs, and which he can evaluate for his own purposes. To this requirement Kainer's book is inadequate.

E. A. COULSON

HUMAN GENETICS

Principles of Human Genetics

By Curt Stern. (Series of Biology Texts.) Pp. xi+617. (San Francisco: W. H. Freeman and Co., 1949.) 5.50 dollars.

THIS text-book deserves to attain a foremost place in university courses of genetics and anthropology. Its merits are many, and it reveals its author as a gifted teacher of the subject. It has arrived at a time when a reliable, balanced and well-documented guide is badly needed by the student of human biology. Prof. Stern offers the book as an introduction to genetics, with man as the organism by which to illustrate the basic principles of genetics. In this respect the book amply fulfils its purpose. There are particularly valuable discussions on the relation between heredity and the environment, multifactor inheritance, mutation and natural selection. The artificial induction of mutation by radiation has become of great, if rather melancholy, importance in human genetics, and the consideration given to this topic here is very timely. Descriptions of the pathological manifestations of hereditary abnormalities have been presented with discrimination.

The book is opportune also in that a large proportion is devoted to an exposition of the more controversial themes in human genetics, those relating to human evolution and differentiation. Prof. Stern handles carefully, and calmly, the modest body of data available at present on such questions of racial genetics as race 'purity' and 'superiority', Negro–White miscegenation and eugenics. In view of the treatment such questions have sometimes received, even at the hands of specialists in genetics in much bulkier tomes, one cannot be too grateful for the guidance the student will derive from this work. Here, one point may be made. Dobzhansky's view that the apparently large morphological differences between fossil Hominidæ (of generic order according to some) do not constitute a bar to their inclusion in one polytypic species deserves special consideration seeing that reference is made to Gates's diametrically opposed, and generally unaccepted, opinion.

The methods used in human genetics are well displayed in the questions set out at the end of most of the more technical chapters.

J. S. WEINER

Organic Chemistry

By Prof. G. Bryant Bachman. (International Chemical Series.) Pp. x+432. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 36*s.* 6*d.*

THIS introduction to organic chemistry is designed as a one-year course for non-chemistry majors in the United States. In Great Britain it could be used by students taking subsidiary chemistry; but more particularly it appears eminently suitable for students taking the general degree in chemistry.

In thirty chapters, Prof. G. B. Bachman provides a lucid survey of organic chemistry, based on the electronic theory of valency, and, without overloading with detail, emphasis is placed on the application of organic compounds to everyday living. The International Union of Chemistry system of naming organic compounds is described, together with notes on pronunciation, which with the probable exception of that for -yl (as in methyl and devil) would find acceptance in Great Britain. Then follow chapters on systematic aliphatic and aromatic chemistry. Optical isomerism is used to introduce an outline of the mechanisms of aliphatic substitution and addition reactions, while the aromatic section is preceded by a chapter on resonance and a brief account of aromatic substitution. Heterocyclic compounds are not neglected in an admirable survey, although this perpetuates the misleading concept of the superaromaticity of furan. There are also excellent chapters on the chemistry of body processes, chemical constitution and colour, chemical constitution and physiological action, and on synthetic polymers. To each chapter is appended sets of exercises and problems.

The production is well up to the standard of the International Chemical Series, though some of the illustrations are rather trivial. S. H. HARPER

Journal of the Institute of Metals

Editor: Lieut.-Colonel S. C. Guillan; Assistant Editor, Major W. G. Askew. Vol. 74, 1948. Pp. xxxviii+804+57 plates. (London: Institute of Metals, 1948.) £3.

THIS volume contains three special lectures and twenty-eight papers, 166 pages of correspondence and discussion, and an index, and one must say immediately that, in every way, it upholds the high standard that one has learned in the past to expect from the Institute of Metals. The Autumn Lecture, by Prof. G. Wesley Austin, on "The Metallurgical Resources of Scotland", the presidential address by Sir Arthur Smouth, in which the history of the Institute is surveyed and its future discussed, and the May Lecture by Prof. A. O. Rankine on "The Search for Minerals by Physical Methods", provide a change from the twenty-eight specialized scientific and technological papers. The latter, which are concerned in the main with metallography, the industrial aspects of the Institute's interests, theoretical metallurgy, and the common ground between the metallurgist and the engineer, add substantially to knowledge in all these fields.

It is, perhaps, invidious to choose for special mention any specific papers where the general level is so high, and any such choice must inevitably reflect the particular interests of the reviewer. To him, however, the papers on "The Equilibrium and Kinetics of Order-Disorder Transformations in Alloys", by Prof. Borelius; on "The Calculation of Loads Involved in Metal Strip Rolling", by Cook and Larke; on "The Determination of the Elastic Moduli of Aluminium Alloys in Tension and Compression", by Grover, Munro and Chalmers; on "The Measurement of the Damping Capacity of Metals in Torsional Vibration", by Cottell, Entwistle and Thompson; on "The Relationship between Stress and Strain for Homogeneous Deformation", by Voce; and on "The Solubility of Hydrogen in Liquid and Solid Aluminium", by Ransley and Neufeld, indicate at any rate some of the particularly interesting papers presented. In addition to these, and as would be expected from the history of the Institute, constitutional work on alloys of high standard is presented in many systems. Further, the industrial interests of the Institute are, directly or indirectly, reflected in many papers, several of which refer to the cracking of alloys, particularly those of aluminium, at temperatures in the region of the solidus.

The work of the editor and of all those concerned with the preparation of the volume deserves the highest praise.

Molybdenum: Steels, Irons, Alloys

By R. S. Archer, J. Z. Briggs and C. M. Loeb, Jr. Pp. xii+394. (London: Climax Molybdenum Co. of Europe, Ltd., 1948.) Free.

THE importance of molybdenum as an essential ingredient of many alloy steels and cast irons is now so well established as to need no stressing. A volume, therefore, which contains a full discussion of the effects of the addition of this element clearly serves a useful purpose. In the book under review, the effects of molybdenum on the structure and properties, both at normal and elevated temperatures, together with the manner in which it may be introduced, are fully discussed. A final chapter dealing with the use of this element in a variety of alloys for special purposes illustrates the unexpectedly wide range of its importance. In magnetic materials, in electronic devices, as elements for thermocouples, in alloys of constant elastic modulus, and even in materials for the dental profession, molybdenum-containing materials find application. There are indications that the compilers have been, perhaps, somewhat enthusiastic in their recommendations of these materials, but the volume is none the less of real value.

Biological Actions of Sex Hormones

By Dr. Harold Burrows. Second edition, entirely revised and reset. Pp. xiii+615. (Cambridge: At the University Press, 1949.) 42*s.* net.

IT is only four years since the first edition of Dr. Burrows's "Biological Actions of Sex Hormones" appeared (*Nature*, 159, 182; 1947). The purpose of the book was to provide a comprehensive survey of literature on the sex-hormones up to the period 1941–42. It has now been amended by the inclusion of fresh material, references being made to some papers published as late as 1947. Its emphasis, however, is still mainly on pre-war work, and Dr. Burrows has not cited several valuable recent reviews on such subjects as ovulation and adreno-gonadal relationships. Nor does he mention the Laurentian Conference discussions or the reviews in *Vitamins and Hormones*.

Shortcomings, however, are inevitable in all books which set out to review a vast subject. The reader has enough reason to be grateful to Dr. Burrows for the work he has done.

INDUSTRIAL APPLICATION OF ATOMIC ENERGY

ONE session of the recent meeting at Birmingham of the British Association, held in the Great Hall of the University, was devoted to an account of industrial applications of atomic energy. The session was opened with a paper by Sir John Cockcroft on the problems and prospects of nuclear power development. The paper covered much of the same ground as the discussions in the World Power Conference; but more information was given about the development work proceeding at the Atomic Energy Research Establishment, Harwell. One of the advantages of the second Harwell pile, the B.E.P.O., is that it can be used at the same time for experiments in nuclear physics, solid-state physics, radiation chemistry and nuclear engineering development. One of the most important problems in nuclear power development is to be able to transfer the heat developed in the uranium fuel elements, safely and efficiently, to a conventional power unit, whether it be a steam boiler followed by a turbo-generator station, or in the long run, perhaps, a gas turbine.

The difficulties arise, Sir John pointed out, from the intense radioactivity developed in the fuel elements, which must not be allowed to leak into the heat transfer fluid, the reactive character of the uranium metal—which oxidizes only too readily, given the opportunity—and the effects of neutron bombardment on the mechanical stability of the fuel elements. The uranium fuel elements have to be 'canned' with a metal of low neutron absorption to overcome these difficulties, and the welds of the can must remain free from pinholes during the long working life of the fuel elements. The B.E.P.O. contains 16,000 fuel elements, and during its two years of operation the working temperature and, with it, the power-level, has been steadily raised, while fuel elements are withdrawn at intervals and examined by X-rays to study any incipient troubles. Metallurgical development has gone along with this, and improved fuel elements have been developed which will allow substantially higher temperatures—of the order of 300° C.—to be reached; and with this the operating power-level should be increased to about 10,000 kilowatts. In order to develop power efficiently, it would be desirable to operate at boiler temperatures similar to those now used in British Electricity Authority power stations, namely, 455° C.; work is therefore proceeding on the metallurgy of beryllium and zirconium, which are promising canning materials for these higher temperatures. The metallurgy of these elements is in an early stage of development, so that some time may be required for the necessary development programme. It will be possible to use the B.E.P.O. to test these high-temperature fuel elements as they come from the laboratories of the Harwell metallurgy division.

Another important problem is the stability of constructional materials and moderators used in the power reactors. Mr. T. M. Fry gave an account of the effects of neutron bombardment on the physical properties of several substances of interest to pure physics. Similar studies are proceeding on the technologically important materials as part of a co-operative programme with the Chalk River Atomic Energy Establishment. The high flux of the Chalk River pile reduces materially the time required for such investigations.

Three new types of power reactors are under consideration. The first is a development of a reactor of the B.E.P.O. type burning natural uranium as its fuel elements. Reactors of this type are near breeders in that the primary fuel element, uranium-235, is partially replaced by the secondary fuel, plutonium, with fission products as a radioactive ash which acts as a 'poison' to the reaction. The 'burning time' of the fuel elements will depend very much on the degree of such poisoning. A hypothetical reactor containing 200 tons of uranium metal and developing 200 megawatts of heat might have a fuel burning-time of between ten and thirty years before its reactivity fell to unity and the chain reaction ceased. Experience is being gained which will decide this point. The burning-time is obviously important since it determines the fuel requirements of such a system, and with it the fuel and therefore the power costs. Burning times of ten and thirty years would require an annual consumption of about 1,800 and 600 tons of uranium metal respectively to supply the power needs of the United Kingdom alone, and such a system could only be supported if the extraction of uranium from low-grade ores could be carried out at reasonable cost. Experimental work on extraction from low-grade ores is now proceeding at Harwell and at the Chemical Research Laboratory at Teddington.

It will not be possible to decide on the feasibility of nuclear power or to give any good estimate of its costs until pilot power-producers are built and operated. Very rough figures of the capital and fuel costs of a modern British Electricity Authority power station compare not unfavourably with guessed figures of the additional cost of the nuclear boiler and limits of cost of uranium fuel elements, assuming refuelling times of ten and thirty years respectively. These figures do no more than show that nuclear power costs will be likely to be of the same general order as conventional power costs, and that it is worth while to proceed with development work to determine these costs more accurately. Pilot plants based on natural uranium fuel elements would be bulky and costly. It is therefore desirable to reduce the scale of pilot power-producers by using enriched uranium fuel elements; feasibility and design studies of such a reactor are now being carried out at Harwell in collaboration with an industrial organisation. Construction will probably take three to five years after approval is given to the project.

Design studies are also being carried out on an experimental breeder reactor, one of which is already under construction in the United States.

This experimental and development programme is likely to occupy the next decade. If the development work is successful, nuclear power would be likely to start in specialized applications where fuel costs are less important, and then to spread gradually to more conventional power stations. British fuel reserves have been estimated as lasting from 200 to 300 years by Dr. A. Parker, director of the Fuel Research Station, Greenwich; power consumption is increasing by 10 per cent a year and there is increasing competition with the chemical engineering industry for fuel. New power sources are therefore of considerable long-term importance, though other potentialities should be pursued in addition to nuclear power.

Dr. H. Seligman spoke next on the immediate benefits which atomic piles are providing, in particular the industrial use of radioactive isotopes. The expansion of radioisotope production at Harwell has been so rapid that practically all the surplus neutron flux in B.E.P.O. is now used, and a limit to the supply of radioactive materials requiring high flux—such as radiographic sources—may very soon be reached, unless measures are taken to increase the available neutrons.

A number of industrial applications were described. The use of thickness gauges using a β-emitter as a source on one side of a continually produced strip and a detector on the other is extending from the paper, plastic and cardboard mills to steel mills, and for this purpose the fission product strontium-90, which emits an energetic β-ray, is required. For this purpose facilities for the separation of substantial quantities of fission products are being installed at Harwell. At present only pilot-scale facilities are operating.

'Static eliminators' containing thallium-204, for the dissipation of undesirable electric charges, are being made experimentally at Harwell and lent to firms for trial. It is thought that in six months or so static eliminators will be available commercially to satisfy all industrial demands.

Other applications make use of the extremely sensitive methods of detecting radioactive elements. For example, radioactive sodium is being used to trace a suspected leak from a lake containing fifty million gallons of water to coal pits. Radioactive bromine contained in an organic compound has been used to check the ventilation system of a factory; radioactive sodium has been used to check the efficiency of mixing of one gram of a vitamin in five tons of cattle food.

Radioactive cobalt has been used in several pipeline operations. At the Gasification Research Station the intersection of two borings in a coal seam was facilitated by inserting a 500-millicurie cobalt source in one seam and a detector in the other. The clearing of long pipe-lines is assisted by making the scrubber radioactive, so that its position can be determined in case of blockages.

These are a few representative applications out of a hundred or so which the Atomic Energy Research Establishment has developed or helped to develop for industry. It is believed that much more use of isotopes could be made in industry, and it is hoped to start at Harwell in the early part of 1951 a training school in their applications.

Mr. W. S. Eastwood described the application of isotopes to radiography in industry. The Harwell pile is now producing γ-emitting sources having conveniently long half-lives—60 days to 5 years—and a wide range of γ-ray energies, so that the energy most suitable for the job can be chosen. The isotopes in most demand are radiocobalt (half-life 5·3 years; energy 1·1, 1·3 MeV.); radioiridium (half-life 70 days; energy 0·30, 0·47, 0·60 MeV.) and radiotantalum (half-life 120 days; energy 0·15, 0·22, 1·13, 1·22 MeV.). In the future, sources of europium (half-life 5 years; energy 0·12, 0·34, 0·41, 1·2 MeV.); cerium (half-life 275 days; energy 1·25, 0·22 MeV.) will be available.

One of the advantages of these radioactive sources is that they are comparatively easily and safely handled, and that they can be reactivated after decay by returning to the pile. They are standardized in the form of cylinders having a diameter equal to length with dimensions of 6 mm., 4 mm. and 2 mm. Specific activities can be as high as several curies per gram. The use of these isotopes is extending steadily in industry, both in Great Britain and abroad. The number which can be produced will be limited by the surplus neutrons available in B.E.P.O.

CLIMATIC LIMITS OF VEGETATION

THE climatic limits of the major types of vegetation and of plant species, especially those of economic importance, are a topic of great practical as well as theoretical interest. In Great Britain it has received comparatively little attention, doubtless because the range of climate in the British Isles is relatively insignificant and the effects of other ecological factors more striking. The subject was therefore appropriate for a joint meeting of Sections K (Botany) and K* (Forestry) of the British Association held at Birmingham on September 1.

Prof. P. W. Richards (University College, Bangor) opened with a discussion of the climatic limits of the Tropical Rain Forest. The optimum conditions for its development are found in areas such as the Malay Peninsula, where the climate is characterized by high and evenly distributed rainfall. Towards the periphery of the Tropical Rain Forest (using the term in the broad sense originally proposed by Schimper), the rainfall becomes more seasonal in its distribution, until a limit is reached where evergreen forest gives way to deciduous forest or savanna. This increasingly uneven distribution of rainfall is accompanied by an increase in the seasonal variation of temperature, but there is little reason for believing that temperature plays much part in determining the limits of the rain forest in lowland country. The altitudinal limit on mountains seems to be partly due to temperature, though even there other factors, such as reduced light intensity due to cloudiness, are probably important. In general, the evidence points to moisture conditions as playing the chief part in limiting the rain forest, which is thus controlled by factors affecting the ability of the vegetation to maintain its water balance rather than by factors affecting photosynthesis or the length of the growing season.

If this is so, we should not expect a very close correlation between the rain forest limits and any simple expression of climate, since factors such as soil texture, drainage, etc., affecting water uptake, are likely to be as important as factors affecting the rate and amount of water lost in transpiration.

The complexity of the factors controlling the boundary of the rain forest is well illustrated in Africa. In the Central Congo basin, Bernard[1] found a satisfactory correlation between the distribution o typical rain forest, peripheral transitional areas and savanna with Köppen's *Af*, *Am* and *Aw* climate respectively; but in West Africa conditions are no so simple. In Nigeria the boundaries between 'Tru Rain Forest' and 'Mixed Deciduous Forest' an between the latter and the savanna seem to b correlated not, as might be expected, with the lengt of the dry season, but with the total annual rainfall As the annual total depends largely on the amoun of rain falling in the wet months, which is far i excess of what can be taken up by the vegetation or stored in the soil, it is likely that the controlling factor is really the evaporating power of the air during the dry season. Recent work has shown a fairly close relation between the vegetational boundaries and the lowest mean monthly relative humidity. The limits of the rain forest in Nigeria are, however, not determined solely by climate, but are also influenced by edaphic factors such as soil depth and texture.

The next contributor, Prof. A. A. Boughey (University College of the Gold Coast), taking the place of Prof. John Walton, who was unable to be present, showed a colour film of Nigeria. The three climatic zones of the West African savanna, Guinea, Sudanian and Sahelian, were depicted.

Prof. A. Austin Miller (Reading) said that a hundred years ago the prospect of finding a simple correlation between the distribution of vegetation and climate seemed good. This optimism had proved ill-founded, and ingenious efforts to replace simple climatic values by more complicated expressions had been unsuccessful because they tried to be universal in application, they ignored factors other than climate, and were attempts to fit the vegetation to the climate rather than *vice versa*. The factors controlling types of vegetation as diverse as Tundra, Steppe and Tropical Forest are probably quite different and must be independently determined.

One control which can be demonstrated to be important, though only at fairly high latitudes or altitudes, is 'accumulated temperature'. This value, also called the 'remainder index', is a device for assessing the accumulated effective warmth, measured in day-degrees, above some more or less arbitrary threshold value. The method of calculating day-degrees recommended by the Meteorological Office cannot be applied on a continental scale; but a good approximation is obtained if the difference between the monthly mean temperature and the threshold is multiplied by the number of days in the month.

The importance of accumulated temperature was recognized by Boussingault in 1837. At first the freezing point was used as the threshold temperature, but later it was found that a figure around 42° F. is more suitable, at least when temperate crop plants are being considered. The basal temperature is different both for different plants and for different plant functions. For citrus fruits, recent work in California suggests 55° F. as the correct threshold and 1,200 day-degrees as the minimum requirement for satisfactory fruiting.

With plant formations the choice of a threshold temperature bristles with difficulties. Nevertheless, there is close agreement between the Arctic timber line and a value of 18 month-degrees above 43° F. Experience is against the view that the efficiency value of each degree above the threshold is equal; but an empirical comparison of climate at the limits of vegetation types is likely to give better results than attempts to fit the increase in rate of growth with rise of temperature to an exponential curve. To illustrate this, data have been assembled for a large number of stations near the northern timber line in Eurasia and North America. In all these stations the mean temperature of the warmest month is higher than 50° F. (thus finally discrediting the 50° isotherm for the warmest month). A growing-season of two and a half months over 43° is enough for coniferous trees in continental climates; but in maritime regions a growing season up to four months is required. Sixteen–twenty month-degrees are needed away from maritime influences. There is no evidence to suggest that temperatures of, say, 50°–60°, are more effective than those of, say, 40°–50°. This gives some encouragement for the belief that, except where superseded by killing frosts, the critical factor limiting vegetation types in high latitudes is accumulated temperature, which can best be expressed as a remainder index. This should give a measure of the heat received, during a period yet to be defined, above a critical threshold.

The last speaker, Mr. J. MacDonald (Forestry Commission), considered a practical aspect of the problem, namely, the importance of climatic limitations in British forestry. In Britain, exotic trees are of prime importance because the native tree flora is so small. Climate restricts the number of species which can be grown and limits the range within which particular species are successful. It affects both the establishment and regeneration of trees and their over-all performance.

In Great Britain occasional severe winters and frosts during the growing season are more important than mean temperatures and variations in the seasonal distribution of rainfall. Eucalypts reach large dimensions in favoured localities in Scotland and could be used in forestry, but for exceptional winters; and Asiatic larches are excluded from practical use because of their susceptibility to late spring frosts.

Japanese larch and Corsican pine illustrate the effect of climate on the range of a species for forestry purposes. The former can grow almost anywhere in Britain, but it is much more successful in the north and west than in south-eastern England, probably because it requires fairly abundant rainfall during the growing season. The Corsican pine also grows in all districts, but is not reliable above 700 ft. This seems to be owing to frosts in autumn; Day has shown that the cambium is still active in October.

Frosts in the growing season are indeed the most hampering feature of the climate of Britain for the forester. This is especially true of Breckland, where frosts may occur even in June and July. A possible solution to this problem is to mix frost-resistant with less hardy species, so that the latter obtain some protection during the stage of growth when they are most susceptible. A more permanent solution may be to select late-flushing strains or to breed in frost-resistance by crossing. One example of the effect of climate on regeneration is the enormous loss of tree seedlings due to frost-lift, especially on impervious soils.

The most important way in which climate affects British forestry is by fixing an upper limit for successful planting. The chief factor involved is undoubtedly exposure to wind, though mechanical injury by snow is also important. Little is known about this subject, because in the past foresters rarely tried to plant trees at high elevations and the natural forests of Britain give little clue to the safe upper limits for planting. Trial plots at various altitudes near Beddgelert in North Wales suggest 1,250–1,750 ft. as the practical limit for forestry, but different species are strikingly different in their behaviour at high altitudes, and much more information is required.

In the open discussion which followed the papers, Dr. Syrach-Larsen (Denmark) pointed out that *Pinus radiata* is an example of a tree with a very small range as a native species, but capable of growing as a crop under a very wide range of conditions. Other speakers stressed the importance of extreme, as well as mean, conditions, and also directed attention to the importance of microclimates.

P. W. RICHARDS

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'FRESHLY FRACTURED SURFACE' THEORY OF SILICOSIS

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FROM time to time, references have appeared in the literature of silicosis to the importance of fresh grinding of silica in the production of disease. Although this question appears never to have been experimentally investigated*, certain recent publications have suggested that the belief in the importance of freshness is widespread, and has influenced the conduct of experiments, as well as leading to the evolution of theories based on the assumption that it has been completely proved. It therefore seems worth while considering the history of this theory, and the evidence for and against it.

The idea appears to have been first mooted in 1935 when, following the publication of the work of Bragg[1] on the crystal structure of silica, it was suggested by Heffernan[2] that this substance's peculiar biological activity could be explained by the presence of unsatisfied valencies at the surface of its particles.

Heffernan recognized that these valencies could be satisfied by hydration, which would occur very rapidly in any normal atmosphere, and therefore it was necessary to postulate, in support of the theory, that only freshly fractured dust was active. There was no evidence in favour of this postulate, and even at that time there was considerable experimental evidence against it. The work of Gardner[3] had shown that it was possible to produce silicosis in animals by exposing them to the inhalation of clouds produced by stirring up commercial ground silica. Although Gardner was in the habit of buying this by the ton ready ground, and keeping it for many years before use, he never observed any deterioration in its power to produce silicosis. Moreover, one of his most strikingly successful experiments[4], which was extensively quoted by Heffernan (*loc. cit.*), was the parenteral injection of graded sizes of quartz, the grading being produced by a tedious process of water sedimentation and decantation, involving the suspension of the silica in water for periods of days before its injection, so that there would be ample time for hydration and leaching of the surface to take place.

The possibility that freshly fractured silica surfaces were especially active was again suggested in 1938 by Briscoe and others[5], as a result of experimental studies of the physico-chemical properties of finely ground materials. They suggested it as a possible ". . . explanation of the failure of attempts in the past to induce silicosis in animals by exposing them to artificially induced dust clouds". They did not state what experiments they referred to; but since there are a number of other possible explanations for the failure of attempts of this kind, a hypothesis which purports to explain the failure of any experiment must also explain the success of those of Gardner.

Although these defects in the 'freshly fractured' silica theory were well known to many workers in the field of experimental silicosis, no arguments were publicly adduced against the theory and, as a result, it became tacitly accepted as true by many people, and was adduced as an explanation of certain other phenomena. For example, Denny, Robson and Irwin[6], in their classical experiment on the prevention of silicosis with metallic aluminium, used a tumble-mill method for the production of the quartz cloud, and attributed the fact that they produced silicosis in rabbits in such a short period as six months to the use of a 'freshly fractured' cloud. In the absence, however, of any precise data about the concentration and size analysis of the cloud (they sampled only with a konimeter), it is unjustifiable to interpret their results in this way.

In 1947 Policard[7] reasserted the theory and gave the following examples:

(1) In spite of the fact that the sheep in the North African desert are continually exposed to the inhalation of sand, they do not develop silicosis. This he attributed to the fact that desert sand was weathered and therefore had no unsatisfied surface valencies.

(2) Sand-blasters are liable to silicosis because, although only exposed to the inhalation of sand which, as stated under (1) above, is weathered, and therefore harmless, the sand is broken up by heat and impaction and therefore presents 'freshly fractured' surfaces.

(3) Silicosis used to be common among millstone workers, in spite of the fact that the concentration of the dust cloud to which they were exposed was apparently very low, because the dust was freshly generated and therefore 'active'.

Policard's statements were not much disputed at the time, although King[8] suggested that the period required for hydration was so short that it would take place usually before the inhaled particles reached the alveoli, and also pointed out that, as mentioned above, Gardner had frequently produced silicosis in animals with dust nearly twenty years old.

The fallacy in the 'desert sand' theory was pointed out later by Heywood[9], who quoted the evidence of Bagnold[10] to show that desert sand contains very few particles less than about 200 μ in diameter and that the airborne dust in the desert comes from adjacent arable land and is almost entirely non-siliceous. The failure of desert sheep to develop silicosis can therefore be readily understood, and the liability of sand-blasters to the condition can be explained simply by their exposure to the finer particles produced by the shattering of the sand grains, without any need to postulate special activity of the surfaces of the particles.

The third example adduced by Policard is entirely speculative, since there is little or no evidence about the concentration and composition of the dust to which the workers were exposed.

These objections, however, appear not to have been generally recognized, and the 'freshly fractured' theory continues to enjoy a popularity for which it is difficult to see any justification. For example, Briscoe[11], Heffernan[12,13] and Policard[14] have all recently reaffirmed the theory without bringing forward any new evidence in support of it, and finally Weyl[15] has suggested a new (though similar) theory, one of the main pillars of which is the assumption that silicosis can only be caused by freshly fractured dust.

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* Recently, Rüttner (*Z. Unfallmed. Berufskr.*, 1, 66; 1950) has published results of experiments in which silica dust extracted from the lungs of deceased silicotics was injected intraperitoneally into mice and shown to be as active as freshly ground dust. These results cannot, however, be accepted without reserve, as the process of extraction of the dust from the lungs involved vigorous treatment with strong acid, which might be said to have created fresh surfaces on the particles.

In brief, Weyl has brought forward evidence that atomic oxygen is present at the surface of ground silica, and he suggests that this explains the peculiar effect of silica on animal tissues. Since the presence of atomic oxygen is a transient phenomenon, the assumption that freshly fractured silica is the only active form is essential to his theory. Another feature of the phenomenon is that it is much more striking in the case of clay than in the case of silica. Weyl fits this observation into his theory by assuming that clay can cause silicosis; in fact, however, clay not only does not cause silicosis, but may even[16] prevent it. It is therefore possible, without disputing the validity of his observations, to say that they are unlikely to have anything to do with silicosis.

Another phenomenon which Heffernan[17] and others have suggested can be explained on the 'freshly fractured' theory is the inhibition of the biological activity of silica by the presence of aluminium. However, it is equally possible to explain this phenomenon on the basis that the activity of a silica particle is concentrated at its surface, a theory which, as will be seen, is almost indisputable.

Although it is possible that freshly fractured dust is, in fact, biologically more active than 'old' dust, it would seem to be improbable; all the information available suggests that the fresh surfaces reach equilibrium with the surrounding atmosphere in a matter of seconds or minutes, and even if they reach the alveoli in an active condition, their activity will presumably be destroyed as soon as they are wetted by the alveolar fluids. Considering that the time required for the development of silicosis in man is a matter of years, and even in the smallest animal a matter of weeks, the importance of such a transient property is likely to be negligible. It therefore seems that, knowing what we do about the great differences of concentration and composition of the types of clouds that are produced by different industrial and experimental procedures, it is unnecessary to postulate such an unlikely mechanism to explain the differences in their toxicity.

Finally, it may be suggested that the question should at any rate be submitted to experimental study. Although this undoubtedly could be done, it would not be a simple experiment. For example, a possible technique would be to expose two comparable groups of animals, one to silica dust from a grinding mill directly and the other to the same dust after it had been collected, stored and redispersed. Apart, however, from the great difficulty of maintaining a constant concentration and size analysis in a grinding mill cloud, the exact imitation of such a cloud by redispersion would require the most refined technique. Moreover, in order to ensure that the two clouds were exactly similar in all respects, including the proportion of very fine particles, it might be necessary to study both by electron microscopy. It will be seen, therefore, that the cost and complexity of the experiment would probably be out of all proportion to either the practical importance or the theoretical interest of the question.

At present, the explanation of the action of silica which is most in favour is the so-called 'solubility' theory[18]. This has been repeatedly and probably justly criticized on physico-chemical grounds, in that the 'solubility' of silica is a meaningless concept. It is true that if silica dust is shaken in water or aqueous liquids for long periods, silica, in a non-particulate form, can be recovered from the liquid, but the amount which will go into 'solution' is a function of time and of the amount and surface of the dust present. Thus, the 'solubility' of silica is not like that of a substance like sodium chloride, the solubility of which (when in a saturated solution) is a function of temperature only, and is unaffected by the amount of solid present, provided that enough time is allowed for complete saturation.

Although the 'solubility' of a given sample of silica *in vitro* is correlated closely with its surface area, its correlation with its pathogenicity, although close, is not perfect, as has been shown by King[18]. However, any other theory which may be put forward about the nature of the surface activity of a silica particle, which purports to describe it or account for its biological effect, must take into consideration the fact that the activity is apparently permanent, and not immediately destroyed by exposure to tissue fluids. In short, it resembles a catalytic action, and while it is true that this does not explain it in any way, it brings it into line with a number of other well-established and thoroughly investigated phenomena in unrelated fields, with the possibility that any discoveries in these fields may prove to be applicable also to silica. Their application, however, will not be possible unless it is clearly understood what precisely are the biological properties of silica which are unique, and which require explanation.

These properties can be summarized as follows:

(1) Silicon dioxide (SiO_2), whether crystalline or amorphous[19,20], when injected into any tissue (not only the lungs) of a large variety of animals, in a suitable form, will produce a series of pathological changes, culminating in fibrosis, which are unlike those produced by any other mineral that has been investigated.

(2) In order to produce these effects, the particles of silica must be less than about 3 μ in average diameter[4] but more than about 100 A. The upper limit is well established but the exact position of the lower limit has not yet been fully investigated. It is known that even if the particles are of colloidal size, they are very toxic[20] but they produce an acute inflammatory reaction not readily distinguishable from that caused by many other substances.

(3) This property of silica is a function of its surface, as evidenced by the fact that: (*a*) it is only shown by particles less than a certain size; (*b*) within limits, the effect of a given weight of silica is proportional to the fineness of the particles of which it is composed; (*c*) it is apparently exerted without obvious loss of material; (*d*) it is inhibited by the presence of a substance such as aluminium or iron oxide which may be adsorbed on to the surface of the silica.

(4) Apart from its own effects, silica has the property of facilitating the proliferation of tubercle bacilli in animal tissue[20], a property which is not shown by other necrotizing substances.

(5) The biological activity of silica, although demonstrable in animals as low as fish[21], has not been demonstrated in tissue culture and is probably not present[22,23]. A considerable amount of further research is required; but it appears that the effect of silica is that of a tissue poison rather than a cell poison.

From what has been said, it is easy to point to a number of lines on which research is needed, either to consolidate ground already partly covered, or to clarify questions at present still obscure.

(1) The whole range between about 3 μ and 100 A. has not been systematically explored, although it has been studied down to $0{\cdot}5\,\mu$[24]. At some point in this range particles become so small that they are for practical purposes colloidal. It would be of great interest to explore this range and study the transition from the particulate to the colloidal effect, since it seems that particles less than a certain size are harmless from the point of view of silicosis.

(2) The apparent synergy between silicosis and the tubercle bacillus may be associated with the fact that their effect on tissue is so similar that it has been suggested by Fallon[25] that it is, in fact, exerted through the same mechanism, that is, the disruption of phagocytes. A limited amount of work on the effect of silica on the tubercle bacilli *in vitro*[26] has led to somewhat inconclusive results but suggests that the stimulation of the growth of the tubercle bacillus occurs only in tissue.

(3) Only a limited number of tissues in a relatively small range of animals has been investigated by the simple technique of injection. The gap between the fish and the tissue culture is a big one, and although a large number of tissues, including lung, liver, spleen, muscle, peritoneum, testis, eye, and subcutaneous tissue have been studied, there are some notable omissions, for example, nervous tissue. It is to be hoped that work will be done to cover these deficiencies.

(4) Although it has been stated by Gardner[19] that amorphous silica is as active as crystalline, the evidence on which this statement is based is, though probably good, somewhat thin[21], and further work to confirm it is required. This work will be complicated by the fact that only certain forms of amorphous silica are active and the presence of relatively small amounts of impurities are sufficient to render it quite inert[21].

(5) It seems to be unlikely on the face of it that silica is unique. The search for substances with similar properties has been limited in the past by the fact that usually only substances of industrial importance have been considered. The suggestion of Evans[27] that other substances with similar crystal structure or physical properties should be investigated is a promising one, and should be further explored. Although Evans's own work on the importance of the piezo-electric property of quartz has not so far produced conclusive results (and is in any case ruled out of court if the evidence of Gardner on the activity of amorphous silica is to be accepted), it would obviously be valuable to explore the properties of a number of minerals in a systematic fashion, in order to compare them with silica.

Having now considered the laboratory investigation of the biological activity of silica, it remains to discuss shortly the assessment of its activity as an industrial hazard. Policard and others have attempted to attribute variation in the incidence of disease in different occupations to the freshness or otherwise of the dust to which the workers are exposed. Speculation of this kind is of limited value unless accompanied by precise quantitative data about the time and intensity of exposure, and the composition and size analysis of the airborne dust. All that has been said above about the activity of silica applies to its activity in the tissues, and information about the composition of the materials from which the dust is derived is of little use unless it is supplemented by studies of the actual dust breathed. Recently, Hatch[28] has reviewed the requirements of a system of dust sampling which will give an adequate description of the hazard, and has pointed out the absolute necessity of a complete study of the size distribution and composition of the airborne dust. It can therefore be said that no statements about the difference in dust exposure between one occupation and another, or one experiment and another, have any validity unless the dust cloud concerned is fully described.

In conclusion, it should be emphasized that there is room for more careful investigation along well-established lines in the study of silicosis and other pneumoconioses. No investigation of an industrial pneumoconiosis hazard is complete without a full description of the cloud as it actually exists in the breathing zone of the men, and, in the case of silicosis at least, it appears that this description should include some electron microscopic studies. Similarly, any animal inhalation experiments are likely to be difficult to interpret unless the cloud to which the animals are exposed is completely studied and controlled, and the difference between the characteristics of their respiratory system and that of man has been fully investigated.

It may be objected that the instruments and techniques for carrying out these investigations do not exist. The answer is that there is no theoretical reason why they should not exist, and that it would be better to spend some time in evolving them than to continue carrying out investigations and experiments in such an incomplete manner that no useful conclusions can be drawn from the results.

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ST. SALVATOR'S COLLEGE, ST. ANDREWS: QUINCENTENARY CELEBRATIONS

By PROF. JOHN READ, F.R.S.

IN 1911, St. Andrews, the oldest Scottish university, celebrated the quincentenary of its foundation in 1411 by Henry Wardlaw, Bishop of St. Andrews. This ancient seat of learning, so rich in history and tradition, has now paid a similar tribute of remembrance to its premier College of St. Salvator, founded and endowed as a residential college by Bishop James Kennedy in 1450. The proceedings opened on September 20 with a commemorative service in the collegiate church of St. Salvator, graced by the presence of Her Majesty the Queen and attended by members of the St. Andrews and Dundee Colleges and School of Medicine of the University, and by leading representatives of State, Church and Law in Scotland, together with academic delegates from many universities, colleges and other learned corporations. At the close of the service of thanksgiving the Queen unveiled a window and shrine in memory of members of the University who fell in the Second World War.

The sequence of events will live long in the memory of all those who were privileged to take part in them. Academic pageantry, gay heraldic shields and flags, bright autumn sunshine, sparkling sea, invigorating air, historic buildings: all helped in the creation of a cavalcade of picturesque scenes truly characteristic of Andrew Lang's "haunted town by the Northern Sea". From the age-old chapel of Bishop Kennedy the company walked in procession along North Street to St. Salvator's Hall, one of the University's most modern and handsome buildings. Here, a group of scarlet-gowned students, mounting a platform at the entrance to the beautiful dining-room, sang in unison the haunting air and words of the Latin grace of the College. The Queen, wearing the scarlet LL.D. gown and black velvet cap of St. Andrews, proposed in gracious terms the toast of the ancient foundation of St. Salvator. "This College," said Her Majesty, "has endured many trials during the past five centuries . . . for these escapes we must be grateful, remembering that it is easier to destroy than to build up . . . the university system of Scotland has undergone many changes in the past 150 years, but the individuality of St. Andrews as a collegiate university remains unaltered, and our societies of masters and scholars flourish beyond the dreams of their founders."

In reply, Sir James Irvine, principal of the United College of St. Salvator and St. Leonard, and principal and vice-chancellor of the University of St. Andrews, said that no honour could be more esteemed than that of the Queen's presence among them. The St. Andrews Colleges bore the same relationship to the University as did the family to the State. It was a remarkable thing that the collegiate system which developed naturally in England at the close of the Middle Ages should have been found adaptable to the changed conditions of the twentieth century. Even the great Universities of Harvard and Yale had adopted collegiate sub-division, which seemed to be the only safeguard against educational mass-production, and the only sure way to preserve the master–disciple relationship in higher learning.

In the afternoon the Duke of Hamilton, chancellor of the University, presided in the Younger Graduation Hall over a large audience, honoured again by the presence of the Queen. In a sparkling commemorative oration, the Earl of Crawford and Balcarres traced the origin and growth of the University and of the College of St. Salvator, and referred to some of the outstanding teachers and students, such as John Napier and James Gregory, whose names live in the records of the College. "In the brave company of St. Salvator's men of action," he said, "we watch young Montrose riding to his matriculation. We find in his rooms his Seneca and Xenophon, his cross-bow inlaid with mother-of-pearl, and his golf clubs. We see him hunting, playing tennis, competing for the silver arrow with his friends Dalkeith, Elcho, Sutherland, Lorne, and passing on to his strange destiny." Applause greeted his reference to "the famous carbohydrate research school of St. Andrews" and to "Sir James Colquhoun Irvine, F.R.S., thirty-fourth successor in direct descent of Master John Almare", who in presiding "over the destinies of our University adds lustre to a great inheritance and will hand to posterity a tradition which he has so much enriched".

Honorary degrees were conferred at this ceremony upon Dr. James Craigie, Mrs. Annie Cameron or Dunlop, Sir W. S. Duke-Elder, Prof. Louis Landré (University of Paris), Prof. J. D. Mackie (University of Glasgow), Mr. S. C. Roberts (Master of Pembroke College, Cambridge), Sir J. T. Sheppard (Provost of King's College, Cambridge), Mr. A. H. Smith (Warden of New College, Oxford), and the Rev. W. E. K. Rankine (Minister of St. Andrews).

On the following day, the first of the Dow Lectures, recently founded by Prof. D. R. Dow to encourage students to gain some knowledge of the rich historical background of the University of St. Andrews, was delivered to a large audience, including delegates and guests, in the Hall of the United College. In this lecture, entitled "The University of St. Andrews in Transition, 1895–1950", Sir James Irvine reviewed the critical period in the history of the University falling within his own experience as student, teacher and administrator. At the end of the lecture numerous visiting delegates presented congratulatory addresses, which were placed for safe keeping in an ancient charter box. The delegates represented academic or other learned foundations, mainly of a collegiate nature and often as old as, or even older than, St. Salvator's College. The Colleges of Oxford and Cambridge, as well as Scottish foundations, were richly represented, and other delegates came from Paris, Dublin, Harvard, Yale, Princeton, and from the Royal Society, the British Academy and other distinguished societies. The good feeling existing between Town and Gown in St. Andrews found cordial expression at the ensuing civic luncheon held in Hamilton Hall, to which members of the University and delegates had been invited as guests of the Provost, magistrates and councillors of the Royal Burgh of St. Andrews.

The celebrations were marked further by the striking of a special medal and the issue of two new St. Andrews University Publications: "The Life and Times of James Kennedy, Bishop of St. Andrews", by Dr. Annie I. Dunlop, and "Veterum Laudes", edited by Dr. J. B. Salmond. Of the twelve chapters of the latter book, three are devoted to the philosophers, the men of science, and the medical men who have been associated with St. Salvator's College.

On each evening of the celebrations, for the first time in the history of St. Andrews, certain of its picturesque buildings were floodlit: these included St. Salvator's Chapel, the United College, the romantic ruins of the Castle and Cathedral, Holy Trinity Church and the West Port. Altogether, the fame that St. Andrews has won as an unsurpassed setting for charming and dignified academic ceremonials has never been better justified than on this memorable occasion in the long history of the University.

OBITUARIES

Field Marshal the Right Hon. J. C. Smuts, O.M., C.H., F.R.S.

In the course of a long and exceptionally active life, Smuts acquired an outstanding reputation as lawyer, soldier, statesman, writer and philosopher. It would have been surprising if a man so versatile had been lacking in appreciation of those advances in the knowledge and practical application of science which have been perhaps the most distinctive feature of the age in which he lived: nor, indeed, was he. He had, I think, no technical training in scientific matters; but I can testify that he followed developments closely and was keenly alive to the social and economic implications of recent scientific discoveries and to their bearing on international relations.

I had many talks with him during the War about the significance of the work on nuclear energy to which so much time and money were being devoted, and I had the opportunity in that connexion of introducing him to Prof. Niels Bohr, whose distinguished record was already familiar to him and of whom he had become an ardent admirer. Thereafter they had many discussions together in my presence. Smuts was thrilled by the possible economic significance of the discovery of vast quantities of low-grade uranium ore in the gold-bearing formations of the Rand. In quite another connexion I found that he had been following with the liveliest interest the recent spectacular discoveries demonstrating the South African origin of the earliest known forms of prehistoric man.

It is, however, in the argument by which Smuts developed the philosophical conception to which he applied the term 'holism' that one finds the clearest evidence of his extensive knowledge and understanding of the course of recent scientific researches. In successive chapters he sets out in non-technical language the basic theories of atomic structure, relativity, the doctrine of the space-time continuum, quantum theory, cell structure, Mendelism and much else. All this collated information serves to sustain his first main contention that the chief gaps in human knowledge are those which separate the phenomena of matter, life and mind, and leads up to, without establishing, his suggestion that in the grand design of the universe there must be an essential unity. From this, two broad conclusions emerge. The mysteries of life and mind may perhaps, when the key has been discovered, be unravelled in the same way as the mysteries of matter; and, while humanity may pass through a "series of vast secular crises", and may be passing through such a period now, all will eventually develop according to the master plan of the Creator. Incidentally, in the absence of knowledge of that master plan, mere human planning will be largely vain, as Smuts more than hinted in his inaugural speech as Chancellor of the University of Cambridge. His faith was ardent, and such was its basis.

In all discussions, military, political or philosophical, the serenity of the man's mind was remarkable. It is, indeed, a tragedy that at this juncture the world should be deprived of his wise, kindly and courageous counsel.

JOHN ANDERSON

Prof. H. Gordon Jackson

Birkbeck College, the University of London and zoological circles have suffered a sad loss by the recent death in a road accident of Harold Gordon Jackson, master of the College and professor emeritus of zoology in the University. Born in Sussex in 1888, he passed his early days in Liverpool, attending Merchant Taylors' School and the University of Liverpool. When qualified, he was appointed research assistant to Sir William Herdman, and spent much time at the Marine Laboratory, Port Erin, and at sea on Herdman's yacht, so acquiring a fondness for marine biology and Crustacea which characterized his later zoological work. In 1913 he was appointed to a lectureship at the University of Birmingham; but the tenure of this was interrupted by service with the Royal Warwickshire Regiment during the First World War.

A long association with the University of London was begun in 1921, when Jackson was appointed reader and head of the Zoology Department at Birkbeck College, newly admitted by the Senate as a school of the University. From that date he played an outstanding part in the development of the Department of Zoology and of the College itself, so that in 1941, when an acting master was required, he was the obvious choice; on Sir John Maud's resignation in 1943, he was persuaded—much against his will, for it meant a cessation of zoological work—to accept the mastership. Started reluctantly, as it was, and at a time when war dangers made the very physical existence of the College a continuous hazard, his period of mastership was an immense personal success. The University pressed the excellent administrator that he proved to be into service in many capacities, so that at the time of his death Prof. Jackson was deputy vice-chancellor, chairman of the Academic Council and a governor of four of its schools. Other bodies, too, gladly took advantage of his skill, and he was, at one time or another, on the Council of the Association of British Zoologists, the Council for the Promotion of Field Studies, the Freshwater Biological Association and the Marine Biological Association.

Prof. Jackson's scientific work was almost entirely concerned with Crustacea, in later years predominantly with the systematics of land isopods, on which he published many important papers. But zoology was only one of many things in which he was deeply interested: music, architecture and literature all occupied his attention, and he could talk as understandingly to his Faculty of Arts as to his Faculty of Science. The main appeal of these (another link with

Herdman) was antiquarian—it was classical music, old castles and churches that aroused his keenest interest, and one would often find him reading some eighteenth-century writer in the 'tube train' on his way to College. Prof. Jackson's main success was, however, personal, and it is in this that his old students and colleagues will remember him—the kindly interest he took in their schemes, great or small; the touches of humour and the deft similes with which he enlivened his lectures; the breadth of his sympathies for, and the wise and tolerant attitude to, the endless succession of activities that make up the daily life of a thriving university college.

A. GRAHAM

WE regret to announce the following deaths:

Sir William Benham, K.B.E., F.R.S., emeritus professor of biology in the University of Otago, on August 21, aged ninety.

Prof. Costantino Gorini, *correspondant* for the Section of Rural Economy of the Paris Academy of Sciences and formerly professor of agricultural bacteriology in the Istituto Superiore Agrario, Milan, on September 3, aged eighty-five.

Prof. E. A. Milne, M.B.E., F.R.S., Rouse Ball professor of mathematics in the University of Oxford, on September 21, aged fifty-four.

Mr. C. T. White, Government botanist in Queensland.

NEWS and VIEWS

Use of the Term 'Vitamin P'

AT the meeting of the Federation of American Societies for Experimental Biology in Atlantic City, April 17–21, 1950, the following recommendation of the Joint Committee on Biochemical Nomenclature of the American Society of Biological Chemists and the American Institute of Nutrition was adopted: "The term 'vitamin P' was first applied to a substance present in lemon juice. It was said to be effective in reducing the extent of hæmorrhages and extending the duration of life in scorbutic guinea pigs and was also proposed for the treatment of vascular purpura. Subsequent studies have failed to substantiate these claims, and the identity of a substance of a vitamin nature has not been established. Continued application of the term 'vitamin P' to one or another of a group of polyphenolic substances will lead only to confusion. It is therefore recommended that the term 'vitamin P' should no longer be employed."

Study of Statelessness

THE United Nations Department of Social Affairs has issued "A Study of Statelessness" (pp. xiii+190. Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1949. 1.25 dollars; 9*s*.), which presents a general survey of national legislation and international agreements relating to stateless persons, and indicates the main systems in force. The survey, which was made at the request of the Economic and Social Council, considers both the improvement of the status of stateless persons and the elimination of statelessness. The former, however, only offers a temporary solution, and the real goal is the elimination of statelessness. As a preliminary measure, the study recommends that States be invited to refrain from taking discriminatory measures against stateless persons in territories under their jurisdiction and to deal with them in accordance with the Conventions of 1933 and 1938. It is also recommended that, in consultation with the International Refugee Organisation and other specialized agencies concerned, a fresh convention be drafted which would include provisions concerning such subjects as personal status, property rights, the exercise of trades and professions, education, a travel document taking the place of a passport, the procurement of documents enabling stateless persons to perform various acts of civil and administrative life, entry, sojourn and expulsion. To eliminate the source of statelessness the study further recommends that every child should receive a nationality at birth and that no person throughout his life should lose his or her nationality until he or she has acquired a new one. Certain principles are also suggested for reducing the number of existing cases of statelessness.

British Institute of Management

IN his chairman's address at the annual general meeting of the British Institute of Management on July 26, Sir Charles Renold said that in little more than two years remarkable progress had been made in getting the Institute established as a national organisation. Its conferences, which are meeting a definite need, have been a major factor to this end. Besides the absorption of the British Management Council and the Confederation of Management Associations and the projected merger with the Institute of Industrial Administration, a further measure of co-ordination is being achieved by the contacts facilitated by the accommodation of various bodies with the Institute at Management House. The goodwill of *Industry* and *British Management Review* has been purchased by Management Publications, Ltd., and, under the new title *The Manager*, the former is being developed as the organ of British management. The Information Service of the Institute is constantly developing, and a series of specialist handbooks is in preparation. A handbook giving full details of the national scheme for intermediate certificates in management studies, which the Institute is conducting in conjunction with the Ministry of Education and the Scottish Education Department, is to be issued, and a subcommittee has been studying the whole question of foremanship training in technical colleges.

Sir Charles referred in some detail to the considerations which have led the Council of the Institute to conclude that the time is now ripe for the Institute to set about the development of professional qualifications in general management as the basis for building a professional membership. The Council recognizes that such professional qualifications are desirable only in so far as they can establish themselves with industry as significant indications of capacity to undertake general management responsibility, and that an indispensable element in granting such qualifications is an assessment of personal qualities. It is intended to make it clear from the outset that the Institute is building for the future, and that its primary concern is with the young manager. Arrangements will nevertheless be made for senior managers, whose practical achievements merit recognition, to be associated with the Institute, for example, in a separate 'transitional' category of professional membership. Referring to the need, already emphasized in the Council's report, for a much greater degree of financial support from industry and commerce if the Institute is to become self-supporting within a reasonable period, Sir Charles said that a new campaign for corporate subscribers is to be started in the autumn.

Mining and Metallurgy Abstracts

THE science and art of metalliferous mining are practised in every part of the globe, and, because no two deposits are exactly alike, the annual output of scientific and practical papers in many countries and different languages is so great that no mining engineer, wishing to keep up to date in current practice, can possibly do so. When to this are added the important ancillary professions such as extraction metallurgy, mineral concentration or 'dressing', applied geology, mechanical and electrical engineering applied to mining, the river of information flowing from the mines is in a perpetual spate. The survey of world literature on mining (excluding coal) and allied subjects (classified according to the Universal Decimal Classification), which is published monthly by the Institution of Mining and Metallurgy, Salisbury House, Finsbury Circus, London, E.C.2, meets a need long felt by members of the allied professions which it serves. The first series, published in the July 1950 issue of the *Bulletin* of the Institution, contains nearly two hundred abstracts, the average length of each one being of the order of a hundred words. When it is remembered that mining is frequently practised in districts far from a library, the value of these abstracts to the manager of a lonely mine becomes apparent. Not only are they useful to the individual in isolated mines; but they also fill a want long felt by busy engineers in more crowded areas because they will save both time and money spent searching the literature. Particular attention is paid to the application of pure science to mining problems, for example, surface chemistry in flotation processes.

Bibliography of Seismology

Two further numbers of the "Bibliography of Seismology", published by the Dominion Observatory, Ottawa, continue the very valuable work of keeping seismologists and others interested up to date with world publications on pure and applied seismology and allied subjects (Publications of the Dominion Observatory, Ottawa. 14: Bibliography of Seismology, No. 4: Items 6858–7003, July to December 1948. By W. G. Milne. Pp. 71–96. No. 5: Items 7004–7131, January to June 1949. By W. G. Milne. Pp. 97–133. (Ottawa: King's Printer, 1949–1950.) 25 cents each). The evaluation of the seismicity of various regions of the earth and the elucidation of earth structure by means of earthquake waves still form a large proportion of research in pure seismology. The study of microseisms continues its world-wide appeal as instanced by W. M. Jones's paper on New Zealand microseisms (item 7058), Marion H. Gilmore's paper on the relation of microseisms to meteorology (item 7035) and others. The accurate delineation of salt domes is also still an incentive to the seismic prospector (item 7032). Seismological items from the columns of *Nature* are listed in the bibliography, and Hirosi Kawasumi contributes twenty-four pages of references to papers written in Japan during 1939–47. Some of these have been published; but others, which have been received at the publication offices of various research institutions and societies in Japan, are intended for publication when the opportunity occurs.

Electrical Power-System Network Analyser

AT the Nelson Research Laboratories of the English Electric Co., Stafford, there was placed in operation at the beginning of the year an alternating-current network analyser. The design and extension of electrical power supply networks nowadays often involve the consideration of a number of alternative schemes, each of considerable complexity and requiring for its analysis a large amount of numerical computation. The amount of computation required for the assessment of a group of such alternatives would be prohibitive. The A.C. network analyser or calculating board is, in effect, a very flexible model which can be arranged to represent the generators, loads and inter-connexions of a power system. The calculating board is so arranged that the appropriate circuit elements can be associated quickly and conveniently to form the required network, and the values of voltage, current and power at various points in the system measured. For the operation of this analyser, a frequency of 500 c./s. has been chosen in order to reduce the size of the iron-cored reactors. Twelve generator units, controllable in magnitude and phase, are available, and impedance units cover the range of impedances normally encountered in power systems. In the metering system negative feed-back amplifiers are employed to operate the instruments, so that the connexion of an instrument disturbs the network to only a negligible extent. The normal applications of the analyser will be to studies of load sharing, fault currents and system stability. This installation is an important addition to the resources of the electrical engineering industry in Britain for dealing with power system problems.

Marine Radar in the Port at Baltimore

IT is reported in the February issue of the *Journal of the Franklin Institute* (249, 173; 1950) that a harbour radar system has recently been installed at the Recreation Pier in the port at Baltimore. This is the third major port in the world to be so equipped, the other two being Long Beach, California, and Liverpool. The radar equipment, which comprises a Westinghouse commercial marine radar unit, provides port operators with a 12½-in. radar chart of harbour shipping movements at ranges from 80 yards to 40 miles. It will be used in a navigational aid research programme designed to assist ships entering and leaving the port of Baltimore in fog and bad weather, to provide continuous observation of harbour shipping, and to give immediate information of the location of shipping casualties in the harbour.

British Scientific Instrument Research Association

THE British Scientific Instrument Research Association has recently published an attractive illustrated booklet describing the activities and various departments of the Association. The Association has the honour of being the oldest of the some fifty existing industrial research organisations operating under the ægis of the Department of Scientific and Industrial Research. It was founded in 1918 and is now an integral part of the scientific instrumen industry with more than a hundred firms in membership with it. Full-page photographs of the individual laboratories at 'Sira' show clearly the excellent facilities available. The chairman of the Association is Sir Ronald Weeks, and Mr. A. J. Philpot is the director of research and secretary.

Courtaulds' Scientific and Educational Trust Fund : Awards

COURTAULDS' Scientific and Educational Trust Fund was formed in 1948 for the promotion of study and research in branches of science with a bearing on textiles, plastics and allied industries. The Fund provides scholarships and also laboratory apparatus and equipment for educational and research institutions. The awards for 1950 have been recently announced as follows.

Research scholarships, of value £375, in a branch of science related to the textile, plastics and other allied industries, and tenable at the places indicated, have been awarded to : D. C. Blackley, C. T. Greenwood and E. J. Hybart (Department of Chemistry, University of Birmingham), T. C. N. Carroll (Christ Church, University of Oxford), A. G. Davies (Edward Davies Chemical Laboratories, University College of Wales, Aberystwyth), Miss J. B. Hayter (Chemistry Department, University of Edinburgh), K. Leedham (Selwyn College, University of Cambridge) ; and one scholarship of £150 to M. Coleman (Department of Chemical Engineering, Imperial College of Science and Technology, London). Research scholarships in textile technology, of value £300, have been awarded to : M. Chaikin and R. Cockburn (Department of Textile Industries, University of Leeds), J. F. Clark and L. B. Hallows (Department of Textile Chemistry, College of Technology, Manchester) ; and one scholarship of £125 (for one year only) to K. W. Geddes (Department of Colour Chemistry and Dyeing, University of Leeds).

Animal Health Trust : Fellowships and Scholarships

THE Animal Health Trust has announced the following awards of research fellowships and research training scholarships : Wellcome veterinary fellowship to P. S. Pugh, for the study, at the Department of Animal Pathology, Cambridge, on metabolism of the ruminant with the view of investigating clinical disorders ; Imperial Chemical Industries fellowship to B. A. Cross, for research, at the School of Physiology, Cambridge, on neuro-hormonal mechanisms in actation, with particular reference to the activation f the posterior pituitary by the suckling stimulus ; Cooper fellowship to K. M. Dyce, to enable him to tudy parasitology, and, particularly, helminthology, t the London School of Hygiene and at the Trust's Equine Research Station, Newmarket ; research raining scholarships to T. A. Douglas, L. W. Hall, . G. Phillips, A. J. Stevens and W. J. Brinley Morgan. The Animal Health Trust, founded in 1942 s the Veterinary Educational Trust, is a body upported entirely by voluntary subscriptions. Since s foundation it has awarded fellowships and scholarhips, totalling more than £52,000, for the extension f veterinary educational facilities in Great Britain.

The Night Sky in October

NEW moon occurs on October 11d. 13h. 33m., U.T., nd full moon on October 25d. 20h. 46m. The llowing conjunctions with the moon take place : ctober 10d. 02h., Saturn 2° N. ; October 10d. 13h., ercury 3° N. ; October 15d. 09h., Mars 4° N. ; tober 20d. 15h., Jupiter 2° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Saturn on October 6d. 08h., Mercury 0·3° S. Mercury is a morning star, rising at 4h. 20m. and 5h. 15m. on October 1 and 15 respectively ; but, as the planet is in superior conjunction on November 1, it is badly placed for observation towards the end of the month. Venus is a morning star, rising about an hour before the sun on October 1 and forty-five minutes before the sun on October 15, but later in the month is too close to the sun to be favourably observed. Nearly all the illuminated disk is visible and its stellar magnitude is $-3\cdot4$. Mars, an evening star, sets at 19h. 25m., 19h. and 18h. 45m. on October 1, 15 and 31 respectively. About October 6 the planet is very close to Antares, after which it moves east of the star. Jupiter, in the constellation of Aquarius, is visible in the earlier portion of the night, setting at 2h. 15m., 1h. 15m. and 0h. 10m. at the beginning, middle and end of the month respectively. Saturn, close to β Virginis during the first week of the month, is a morning star, rising at 4h. 45m. and 3h. 10m. on October 1 and 31 respectively. A large number of occultations, mostly in the constellation of Taurus, occurs during October, especially on October 28, and the following list is limited to stars brighter than magnitude 6 : October 4d. 0h. 19·9m., 49 Auri. (*R*) ; October 21d. 23h. 32·4m., *h* Aquar. *m* (*D*) ; October 28d. 02h. 58·8m., 17 Taur. (*D*) ; October 28d. 04h. 02·4m., 20 Taur. (*D*) ; October 28d. 04h. 05·8m., 23 Taur. (*D*) ; October 28d. 04h. 07·9m., 16 Taur. (*R*) ; October 28d. 04h. 18·2m., 17 Taur. (*R*) ; October 28d. 04h. 36·1m., η Taur. (*D*) ; October 28d. 04h. 40·3m., 20 Taur. (*R*) ; October 28d. 04h. 41·7m., 23 Taur. (*R*) ; October 28d. 05h. 40m., η Taur (*R*) ; October 28d. 19h. 57·6m., χ Taur. (*R*) ; October 31d. 23h. 51m., 47 Gemi. (*R*). *D* and *R* refer to disappearance and reappearance respectively, and the latitude of Greenwich is assumed.

Announcements

LORD RUSSELL and Lord Dunsany will be the chief speakers at a dinner which the Philosophical Society of England will hold on October 4 at the Waldorf Hotel, in honour of Lord Russell, who is patron of the Society. This Society, which was founded in 1913, was reconstituted in 1948, and has since had its headquarters at 11 Chandos Street, Cavendish Square, London, W.1.

TWO series of lectures on special aspects of dairy technology have been arranged by the Department of Chemistry, Chelsea Polytechnic, Manresa Road, London, S.W.3. They are designed for persons holding executive posts in dairy or allied industries and those of professional standing in food chemistry, public health, etc. Both series consist of four lectures, which will be given on Tuesdays at 7.15 p.m., starting on November 14 and February 13, respectively, and the cost of each series is 7*s.* 6*d.*

THE United Nations Educational, Scientific and Cultural Organisation is compiling a list of requests from libraries all over the world for out-of-print war-time issues of journals and other publications. It is hoped to fulfil these appeals by obtaining surplus copies from libraries and private collections, and, so far as Great Britain is concerned, the British National Book Centre will be used as the collecting centre. Those who have surplus copies to spare should get into touch with the British National Book Centre at the National Central Library, Malet Place, London, W.C.1.

INFLUENCE OF TEMPERATURE ON THE MICELLARY SIZE OF SALT AEROSOLS

By PROF. L. DAUTREBANDE
Stanford Research Institute, Stanford, California

AEROSOLS of a micellary size less than 1 micron, and made of salts in water or other volatile media, evaporate within a fraction of a second at room temperature and relative humidity less than 80 per cent[1], thus leaving behind in the atmosphere the remaining crystals or solid remnants of the solute. Unless the outlet of the aerosol generator is directly connected with an atmosphere of high relative humidity, these solid particles constitute the aerosol. The evaporation of small spheres, such as are produced, is accurately proportional to the radius of the sphere and not to its surface[2-4]. This process of evaporation can be accelerated by warming up the aerosol immediately after its production[5,6], thus reducing the size of the micelles to a considerable extent. The reverse is also true. If an aerosol containing dry particles of sodium chloride, for example, is cooled, the solid particles recapture water from the saturated air and form large coalescent droplets. By this simple method, one can not only obtain large particles from an aerosol initially composed of very small micelles, but also produce large aggregates, in fact much larger in size than are generally observed at room temperature and normal relative humidity, with the same material and the same aerosol generator.

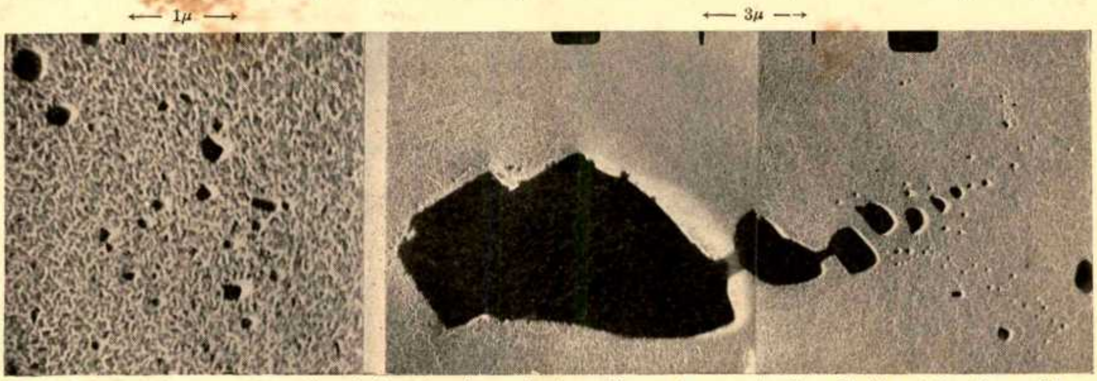

Fig. 1. Influence of temperature on the micellary size of aerosols. Aerosol from a 1 per cent sodium chloride solution dispersed by a hand-bulb-operated generator (No. 15) through a tube 200 cm. × 5·5 cm. for 5 min. and collected during 2-hr. sedimentation on collodion screens placed at the bottom of the tube at points of different temperatures. Left, at 32° C. Right, at −5° C. Electron microscope. Gold-shadowed. Note the formation of large aggregates in the cooled aerosol

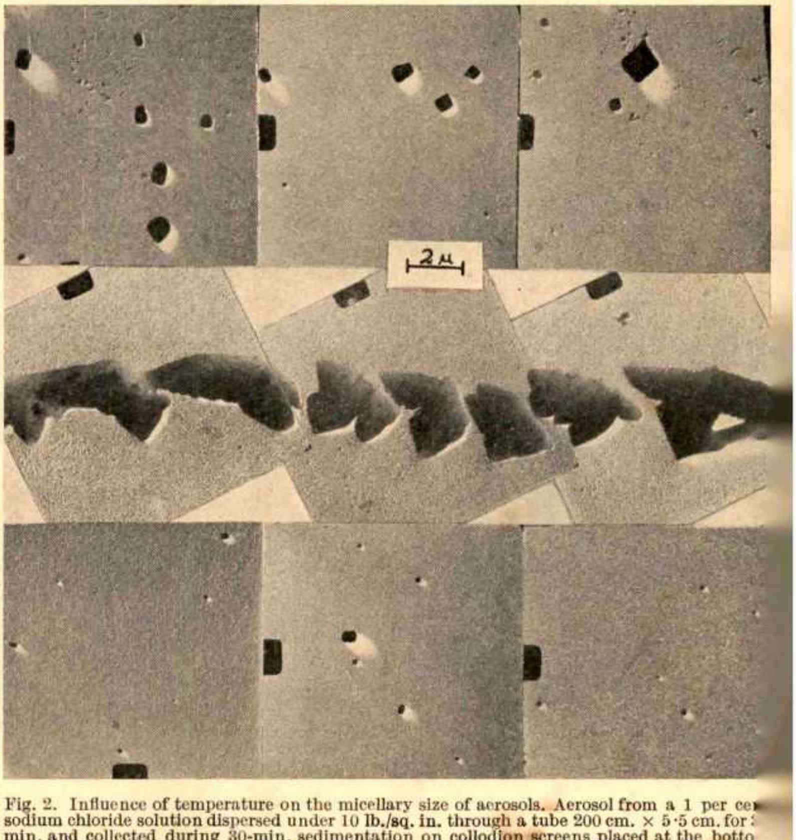

Fig. 2. Influence of temperature on the micellary size of aerosols. Aerosol from a 1 per ce sodium chloride solution dispersed under 10 lb./sq. in. through a tube 200 cm. × 5·5 cm. for min. and collected during 30-min. sedimentation on collodion screens placed at the botto of the tube at points of different temperatures. Top, at 22° C. before region of coolin Centre, at −29° C. Bottom, at 22° C. after the aerosol had passed through a region heat to 160° C. Electron microscope. Gold-shadowed

An aerosol was produced by a Generator No. 15, described elsewhere[7], then passed through a glass tube 200 cm. in length by 5·5 cm. inner diameter for 5–30 min. At different points in the tube the temperature of the aerosol was varied by heating the tube locally (100–160° C.) with an electric resistance or by cooling it with 'dry ice' (0 to −30° C.). Slides bearing collodion screens were placed at the bottom of the tube at points where the temperature was normal, where it was low, and immediately after the heating point and/or after the cooling point (where the temperature was normal again). Immediately after the aerosol dispersion was completed, the tube was sealed at both extremities and the aerosol allowed to settle down for 30 min., 1, 2, 3 and 15 hr. Fig. 1 shows the appearance of an aerosol from a 1 per cent sodium chloride solution collected at 32° C. and at −5° C. respectively. It can be seen that the cooling of the aerosol (*a*) increases the particle size, (*b*) increases the extent of aggregation, and (*c*) increases the amount of material collected, as a result either of a more rapid sedimentation or of the thermal precipitation gradient.

Fig. 2 shows the appearance of an aerosol collected at 22° C., at −29° C., and after warming up. It can be seen that particles which have escaped the cooling-off precipitation (at −29° C.) are smaller after heating (lower row) than before heating (upper row).

Fig. 3 shows the appearance of an aerosol collected at 22° C., at 0° C., and again at 22° C. after the cooling-off region. The photograph shows that the aerosol which has not been collected in the cold region (at 0° C.) is composed of a mixture of large and small particles.

It is believed that this simple procedure of cooling the aerosol can be applied (*a*) in therapeutics for the treatment of the upper respiratory passages (where large particles are deposited preferentially) simultaneously with the treatment of the lower respiratory tract (where small particles readily penetrate); (*b*) to atmospheres containing fine dust particles, with or without the addition of aggregating aerosols[8-11]; similarly, to industrial recovery of waste, toxic or valuable products (stacks, cyclones, chimneys, scrubbers, etc.); and (*c*) to local conditioning of animal or plant textile fibres[12], etc. These variations in the micellary size of aerosols may also play a part in the production of some phenomena related to the pollution of the atmosphere (visibility[13,14], eye, nose and throat irritation[15], etc.).

These experiments have been made with the assistance of Messrs. R. Capps and J. Shaver. The electron microscope photographs were taken by Mr. C. Glassbrook. [Feb. 10.

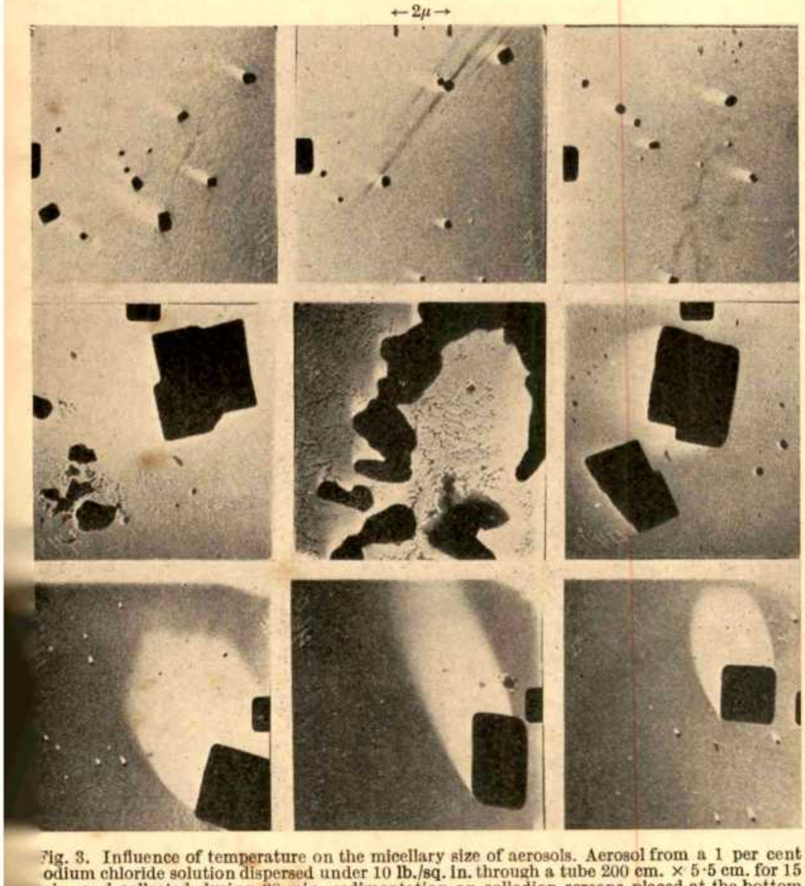

Fig. 3. Influence of temperature on the micellary size of aerosols. Aerosol from a 1 per cent odium chloride solution dispersed under 10 lb./sq. in. through a tube 200 cm. × 5·5 cm. for 15 min. and collected during 30-min. sedimentation on collodion screens placed at the bottom of the tube at points of different temperatures. Top, at 22° C. Centre, at 0° C. Bottom, at 22° C. after the aerosol had passed through the cooling region. Electron microscope. Gold-shadowed

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FUNGUS DISEASES OF ANIMALS

ALTHOUGH fungi are less important than bacteria as pathogens of man and animals (the converse of the relationship of these organisms to disease in plants), the first parasitic disease to be recognized was the 'muscardine' disease of silkworms caused by the fungus *Beauveria bassiana*. This discovery by the Italian worker Bassi in 1835 opened a new era in the understanding of disease and helped to pave the way for the development of bacteriology later in the century. The indisputable significance of bacteria to medicine and veterinary science led to the almost total eclipse of medical and veterinary mycology, and only during the past few decades has it been realized that fungi pathogenic for man merit careful and intensive study even if they are responsible for few major diseases. During the nineteenth century a number of mycotic infections of man and animals were described, for the most part by medical men with no special training in mycology. Professional mycologists, on the other hand, who moved so freely in and out of the field of plant pathology, rarely ventured into medical territories, to the detriment of both medicine and mycology. Since the First

World War, however, and particularly in the United States, fungi of medical importance have been studied by trained mycologists working in close contact with medical men and the results have at times been spectacular. More recently, in Great Britain, too, there has been a revival in interest in medical mycology; but here, as elsewhere, veterinary mycology has been neglected, and the first veterinary mycologist in Great Britain and the Commonwealth has yet to be appointed. Symptomatic of the growing interest in fungus diseases of animals was the meeting of the British Mycological Society held at the University of Reading on July 26, when veterinarians, medical men and mycologists devoted a day to the discussion of problems of common interest.

The meeting opened with an account by Mr. J. D. Blaxland (Ministry of Agriculture's Veterinary Laboratory, Weybridge) of moniliasis in turkeys. This disease, first recognized in the United States in 1932 [1], was unrecorded for Great Britain until 1949, when five outbreaks, involving the death of more than eight thousand of a total of twelve thousand turkey poults, were investigated by Blaxland and Fincham[2]. The affected poults did not usually show any diagnostic symptoms. Young birds dying from acute disease were of normal body weight; but older birds infected for a longer period showed uneven growth and a general unthriftiness. On post-mortem examination, however, crop lesions were usually found either as a flocculent greyish-white exudate adherent to the underlying mucous membrane or, in chronic cases, as a thickening of the crop wall, the inner surface of which was covered by a mass of yellowish-white necrotic material giving a 'turkish towelling' effect.

From these crop lesions isolations were made of the yeast-like fungus *Candida albicans*, the subject of a paper by Miss P. M. Stockdale (University College, Exeter), in which she described the methods commonly employed for the determination of the morphological and physiological characters used for the differentiation of this and other species of *Candida*. The circumstantial evidence all pointed to the responsibility of *C. albicans* for the death of the birds and for the infectious nature of the disease; but the factors underlying these epidemic outbreaks are not clearly understood. Infection experiments, still in progress, on turkey poults and chicks with strains of the fungus strongly pathogenic for rabbits have not resulted in epidemics, and in some instances after a period of sub-normal development the young birds appear to have recovered, although *C. albicans* has been isolated from representative individuals killed for cultural and histological examination. It was noticed in the naturally occurring outbreaks that some birds showed symptoms usually associated with nutritional deficiencies and also, in certain cases, nervous symptoms recalling those of Newcastle disease. In only one of four of the outbreaks for which data were available was there evidence of unsuitable diet, but in two the hygienic conditions were poor.

Additional evidence for the complex etiology of moniliasis in poultry has been obtained from a survey of the incidence of crop lesions and of *C. albicans* in turkeys and turkey poults, chickens and chicks, and in ducklings, geese and goslings which have come up for routine post-mortem examination at the Veterinary Laboratory since the beginning of this year. Most of these birds had died from other causes, but from 9 per cent of 127 turkey poults and 43 per cent of 73 adult chickens *C. albicans* has been isolated from birds which in some cases exhibited crop lesions and in others did not. It would thus appear that *C. albicans* is not uncommonly associated with normal birds, and in poultry, as in man, the origin of the moniliasis is endogenous; and that similar difficulties are likely to be experienced in evaluating the significance of yeasts found associated with pathological conditions.

Dr. R. E. Rewell, until recently pathologist to the Zoological Society of London, dealt with aspergillosis of birds and other animals, a disease which in contrast to moniliasis has an exogenous origin. Aspergillosis, caused by *Aspergillus fumigatus* and less frequently by other species of *Aspergillus*, takes an annual toll of birds in the London Zoo and also of poultry throughout Britain. It is characteristically a disease of the respiratory system. The air sacs are the region most frequently affected, and it is only occasionally that the abdominal viscera are also involved. Usually, lesions in the abdominal viscera are tuberculous, and in a survey carried out at the London Zoo during 1946–48 [3] no evidence was obtained to support earlier claims that infection by *A. fumigatus* and the tubercle bacillus may occur in the same organ. The time of incidence of aspergillosis shows an interesting contrast to tuberculosis. The former is primarily a disease of the early days of captivity, while the latter attacks birds long captive. During the recent survey, of 76 birds dying from aspergillosis, 62 had been less than six months in the Gardens, while 36 of 42 birds dying from tuberculosis had been more than six months in captivity. In Dr. Rewell's opinion there is no authentic record of tuberculosis in a bird in the wild, contact with domestic poultry being the most plausible explanation of the few recorded cases. On the other hand, evidence that wild birds suffer from aspergillosis is very strong, though not conclusive. Attention was also directed to aspergillosis in a buffalo[4] and to an epidemic of this disease in a colony of wallabies at the Whipsnade Zoo. An interesting case of a condition resembling thrush in a shoebill from which *C. albicans* was isolated was also recorded.

A number of fungi pathogenic for animals and man are yeast-like in the parasitic phase and mycelial under the usual conditions of culture. This phenomenon may be an adaptation for parasitism; but it is perhaps more probable that it is a potential 'dimorphism' which enables such species to invade new habitats. *Histoplasma farciminosum*, the cause of epizootic lymphangitis in equines and a dimorphic species, was discussed by Dr. J. J. Bullen, who, after gaining experience of the disease while on service in Assam and Burma during the Second World War, has since studied the physiology and serology of the fungus at the Institute for Animal Pathology, Cambridge, where he succeeded in elucidating the conditions for effecting the mycelial-yeast transformation by adjusting the environment[5]. The disease, which is endemic in countries bordering the Mediterranean but absent from Britain, shows other interesting features. The characteristic symptom is the development of abscesses in the superficial lymphatic vessels which in the course of about three months spontaneously heal but not before fresh abscesses have developed farther along the affected vessel. The course of the disease is protracted and control of outbreaks, by isolation and slaughter, very difficult. Weeks or even several months after the apparent elimination of the disease from a group of horses or mules a new case may appear. The epidemiology is obscure; but it is highly probable that the parasitic activity of *H. farciminosum* is confined to equines and thus it differs from the allied fungus *H. capsulatum*, the cause of histoplasmosis in man, dogs and certain rodents, which was one of the examples mentioned by Dr. J. T. Duncan in a comprehensive review of the relation of mycoses of animals to disease in man.

Histoplasmosis is one of the group of mycotic diseases including coccidioidomycosis (*Coccidioides immitis*) and sporotrichosis (*Sporotrichum schencki*), in which man and animals are subject to the same external hazard of infection by fungi able to live saprophytically. In such diseases the animal hosts are often of considerable importance in epidemiological studies on the disease in man by indicating the geographical areas in which the parasite is endemic and also, as in coccidioidomycosis, by helping to propagate the parasite. In contrast to this is another group of mycoses in which man contracts infection directly from a diseased animal. Sometimes the reverse occurs, as when the school cat becomes infected from a child with ringworm, which is a typical disease of this type. Cats, dogs and cattle are very generally infected by dermatophytes, and in most country districts almost all human ringworm is caused by fungi derived from animals, in contrast to the predominance of specifically human ringworm fungi in large towns. No serious efforts are made to control dermatophytes on domestic and farm animals, so a large reservoir is available from which farm workers can contract infection, sometimes sufficiently severe to involve a period in hospital, and through the agency of which the education of children can be disturbed.

Actinomycetes, perhaps more properly classified as bacteria but often referred to the mycologist for identification, also came under discussion. Dr. Rewell noted a disease of wallabies attributed to an aerobic member of the group, while attention was directed to the anaerobic forms which cause actinomycosis in man and cattle by Mr. D. Oxford, who has recently begun a study of the status of the human and bovine pathogens. Mrs. Oxford would be grateful for material of these diseases, which should be sent to her at the Department of Bacteriology, Foresterhill, Aberdeen.

G. C. AINSWORTH

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INTRA-CELLULAR DISTRIBUTION OF VITAMIN C IN THE ADRENAL CORTEX

By DR. GEOFFREY H. BOURNE
Department of Histology, London Hospital Medical College

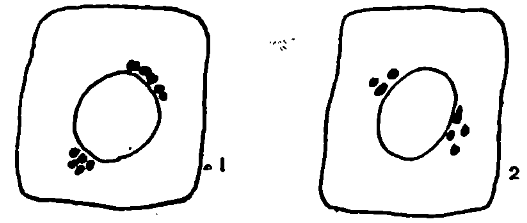
ATTENTION has been directed to the localization of reduced silver granules in the Golgi region of drenal cortex cells after treatment with the vitamin C reagent, acetic acid – silver nitrate[1,2]. Afterwards, arnett and Fisher[3], basing their observations on hemical models, claimed that the localization of the ranules in the Golgi region was no indication that the vitamin was localized there. Certain fallacies in their argument were pointed out by Bourne[4]. Sosa[5] has claimed that silver granules produced after treatment with the vitamin C reagent only occur in the Golgi region if the preparation is afterwards 'fixed' in hypo. Dean and Morse[6] have stated that the granules only appear in the Golgi region of adrenal cortical cells if the gland is fixed more than five minutes after death. Hoch Ligeti and Bourne[7] have, however, shown that there is a cycle of distribution of vitamin C granules in the adrenal cortex. One stage is represented by the aggregation of the granules in the Golgi region, another by the presence of numerous fine granules aggregated near the inner surface of the cell membrane and a third by the discharge of the granules from the cell into the cortical sinusoids.

Claims for and against the localization of vitamin C in the Golgi region are dependent upon what is meant by the Golgi apparatus, and recent work by Palade and Claude[8] suggest that it might be desirable to reconsider our views on this problem.

Palade and Claude claimed that common Golgi fixatives cause the production of myelin forms from numbers of phospholipoid vacuoles already existing in the cell, and that it is these artefacts which are normally described as the Golgi apparatus. The authors claim that the myelin forms are produced by either the primary acidic reaction of the fixative, or by a secondary acidity produced by the reaction of the fixatives on the tissue. In view of the high acidity (10 per cent acetic acid) of the vitamin C reagent, it was considered desirable to study the penetration of this reagent into tissue disks, as used by Palade and Claude, prepared by crushing small pieces of tissue between slide and cover glass and permitting the reagent to penetrate at the periphery.

Pieces of adrenal cortex of the rat were prepared in this way, and the penetration of the silver nitrate–acetic acid reagent studied under oil immersion.

There is, first of all, a clear fringe, which appears to be the acid, advancing towards the centre of the disk from the periphery in which the protoplasm of the cells becomes precipitated. The silver ions appear to penetrate more slowly, and their penetration can be seen first of all as a yellow zone, followed by a wine-red zone, both of which move forward in order from the periphery towards the centre of the disk. The colour of these zones appears to be due to the reduction of the silver by vitamin C liberated from damaged cells and localized between the intact cells. As the yellow zone advances from the periphery, black granules can be seen forming in the cytoplasm of the cortical cells, and they become much darker when that region is overtaken by the wine-red zone. The granules in the cells in the outer part of the disk, which represented the outer zona fasciculata and zona glomerulosa, are localized in a juxta-nuclear (Golgi) region of the cell. Many of the inner cells of the disk, representing the inner fasciculata and the reticularis, showed numerous small granules scattered through the cytoplasm and not localized near the nucleus. This tendency for the outer cells of the adrenal, particularly those of the zona glomerulosa, to show localization of silver granules in the Golgi region, and of many of the inner cells to show the granules more widely distributed in the cytoplasm, is characteristic of the picture one frequently obtains from vitamin C preparations of the adrenal made in the normal way. The way these granules appear is



Figs. 1 and 2. Showing disposition of vitamin C granules in zona glomerulosa cells 30 sec. after contact with acetic acid – silver nitrate solution. Note that granules appear to have run together in one part of Fig. 1

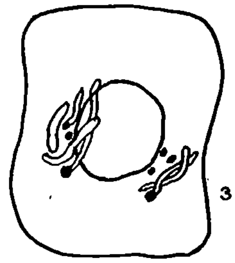


Fig. 3. Cell of outer zona fasciculata twenty minutes after treatment with acetic acid – silver nitrate solution. Note myelin bodies and some black granules in association with them. Note other black granules separate from myelin bodies

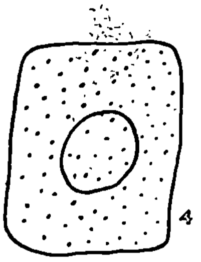


Fig. 4. Cell of inner part of zona fasciculata 30 sec. after contact with acetic acid – silver nitrate. Note fine black granules scattered through the cytoplasm

of interest because it has been suggested that the vitamin C is not localized in any cell organelle, but that it is diffused throughout the cytoplasm. The apparent localization of these granules in the formed elements of the cell, it has been suggested, may be due to the aggregation of the silver particles in these regions following their production in the cytoplasm by the vitamin present there. If this were the case, one would expect the granules to come slowly into view, but in fact they come very suddenly into view; one moment they are not there and the next they are visible. This is not what one would expect if they developed in these sites only as a result of diffusion of silver micelles from the rest of the cytoplasm.

It is of interest that M. R. Lewis has shown[9] that if mice are fed Nile-blue sulphate, fine blue granules may be seen scattered through the body of many of the cells of the cortex. She found the distribution of these granules to correspond exactly with the distribution of silver granules in the adrenal cortical cells as demonstrated in rat adrenals by Dean and Morse[6] and in chick embryos by Barnett and Bourne[10]. Since the lipoid vesicles, from which Palade and Claude[8] claim myelin figures develop, have the ability to concentrate dyestuffs, these results suggest that, even when the vitamin C granules are widely distributed in the cell, they are still incorporated in what represents—although they are not localized near the nucleus—the Golgi system, or complex, of the cell.

After the disk preparations of the adrenal cortex had been under the influence of the vitamin C reagent for ten to fifteen minutes, myelin forms began to develop in the cells; but they did not blacken with the reagent, thus indicating that they contained no vitamin C.

After three minutes penetration, there was no sign of the yellow zone, and the first indication of the advancing silver ions was the sudden development of granules in one cell after another. In the inner parts of the disk Liesegang rings became obvious; their frequency was less than the diameter of a cell, so that individual cells had one or two bands across them in which the granules appeared more concentrated. It is of interest that Liesegang rings have never been observed in adrenals impregnated in the usual way by the vitamin C reagent.

These experiments support the observations of Palade and Claude[8] that treatment of cells with acids may cause the development of myelin forms. They also suggest that the Golgi nets described in the adrenal cortical cells are artefacts, and that the true Golgi element of the cortical cell may be represented by a series of vacuoles, probably phospholipoid in nature, which have the ability to segregate various substances, including dyestuffs. They confirm my previous contention that vitamin C is not diffused through the cytoplasm but is localized in the Golgi vesicles of the cell. They also show that although vitamin C is found in the Golgi vesicles it is not necessarily present in the myelin forms which have been described as the Golgi apparatus in the past.

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OPERATIONAL RESEARCH

APPLICATION TO PEACE-TIME INDUSTRY

SCIENCE in Great Britain is often accused of lagging far behind that in the United States in its application to industry. It is encouraging, therefore, to see the development in industry of the war-time technique of operational research. Such research is an attempt to apply scientific methods to determine the effectiveness of operations. The application was clear enough in many war-time problems where there were complex organisations, new apparatus and often inexperienced executives. It has the same role in industry—to discover and marshal the facts as an adjunct to the executive's experience and judgment and so help him to make rational decisions

Many of the successes of operational research com from the study and improvement of traditiona methods; it is, therefore, sometimes looked upon a a short-term policy to get quick results. Were it n more it would be valuable; but that it can do an is doing more is shown by the lectures and discussion held under the auspices of the Manchester Join Research Council during the winter of 1949–50, no published as a booklet*.

An introduction by Prof. P. M. S. Blackett, r printed from the *Operational Research Quarterly*, pose two questions: Is it scientific? Is it new? Th first he answers "yes by definition"; the second not so easily answered categorically. Prof. Blacke finds newness not so much in the material to whic the scientific method is applied as in the level which the work is done, in the comparative freedo of the investigators to seek out their own problems and in the direct relation of the work to the possibilities of executive action. One of the lecturers, Mr. A. W. Swan, puts rather a different view. In defining operational research as scientific management plus the statistical approach, he infers that the statistical approach is what makes this a new subject. The truth perhaps lies in a combination of these two ideas : on one hand the development of new scientific methods applicable to the problem (particularly the statistical approach) ; and, on the other, the development of a new scientist-executive relationship which makes possible the application of the new methods.

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* Operational Research: its Application to Peace-time Industi Pp. 152. (Manchester: Manchester Joint Research Council, 195 10*s*. 6*d*.

In the series of five lectures, examples are drawn from a wide field. Mr. H. Bradley shows how analysis of foot dimensions has pointed the way to a more rational range of shoe sizes. Mr. D. Hicks outlines the task of operational research in the coal industry, and Mr. L. H. C. Tippett shows what has been done by the Cotton Industry Research Association. An example of a study of the operations of a steel rolling mill is given by Mr. A. W. Swan, and Dr. W. H. Glanville explains some of the problems undertaken by the Road Research Laboratory of the Department of Scientific and Industrial Research.

These examples admirably illustrate the type of problem which the operational research scientist may be expected to answer. They do not perhaps always so clearly demonstrate the relationship between scientific worker and executive which is necessary to achieve successful results. Sir Raymond Streat finds this failure particularly obvious in the case of the two research associations and concludes that research associations, although doing much excellent operational research in the general field, lack the close contact with the executive which would be necessary for them effectively to carry out projects of this type in individual firms. It might be added that research associations are primarily concerned with their industry as a whole and mostly lack resources to commit to specific projects of interest only to individual firms. This leads on to a discussion of the important problem of the application of operational research in firms which are too small to have their own organisation for the purpose. It is clear that there is a strong case for some outside body to supply specialist operational research workers for particular investigations in such firms ; and the tentative conclusion is reached that the most likely source of these is from paid consultants.

The special position of the operational research investigator in the works calls for outstanding qualities of personality. He must work for, and report to, the high executive ; yet he must also win the confidence of the shop managers and workers if he is to be able to pursue his investigations freely and gain access to the essential facts. There is danger, however, of over-emphasizing the importance of this aspect and of forgetting the essentially scientific nature of the work. Operational research is more than just common sense. In the discussions at Manchester there appears such a tendency to stress the importance of 'the right personality' almost to the exclusion of anything else, scientific ability being held at a discount. Scientific ability and personality are not incompatible, and both are required in operational research.

In discussions of the technical knowledge required, it seems to be the general opinion that an operational research worker does not need a detailed knowledge of the industry in which he is to pursue his investigations. Indeed, it is argued that only a minimum of such knowledge is to be preferred, since much of the value of operational research lies in ceaseless probing of existing practices, and it is difficult to question practices which one has been brought up to accept. There is, however, much in the alternative view that the operational research worker will be lost without considerable background knowledge. The solution may lie in team-work; the team could be led by an outsider, who could introduce the new ideas and take away on his departure any opprobrium which might arise through unpopular recommendations; while some, at least, of the rest of the team could be normally employed in the factory or shop.

A final verdict is not yet possible on operational research. This booklet sets out to clarify thought on the subject; in this, it could perhaps have been improved by judicious editing to avoid the verbatim reporting of minor exchanges which are sometimes tedious in print. Nevertheless, it contains important ideas and opinions and well merits study by those interested either academically or industrially.

R. T. EDDISON

ADVISORY COUNCIL ON SCIENTIFIC POLICY

THIRD REPORT

WHILE the most important feature of the third report of the Advisory Council on Scientific Policy is the support it affords for the establishment of one or more higher technological institutions, with suitable governing bodies of their own but fitted into the university system, the report also contains ample evidence that the Advisory Council is discharging its other standing responsibility of reviewing the appropriate organisation for scientific research in government establishments in Britain. On the question of scientific man-power, the Advisory Council remains a little hesitant. It is plainly dissatisfied with the accuracy and comprehensiveness of the results obtained from the Ministry of Labour's Survey of Scientific Manpower, at least as a basis for concrete recommendations ; but the Council should be seeking rather than hoping for other means of providing this type of information. Data collected by the Ministry of Labour lead to the general inference that we are approaching a point where the short-term demand for trained scientific workers may be satisfied, but where temporary maladjustments may occur ; continuing shortages of chemists and chemical engineers and a probable surplus of biologists are specifically mentioned, while special stress is laid on the serious shortage of science teachers in schools and the probability that the present level of salaries will have unfavourable effects on the quality of men of science recruited for the teaching profession.

Here, as in the question of the supply of technologists, the Advisory Council does not accept the existing demand as the sole criterion. It believes rightly that if the value of qualified men of science in executive positions is properly appreciated the demand for them will show a marked increase, and, similarly, that the existing demand for technologists should not be taken as a measure of the numbers needed if British industry is to maintain and improve its position in the world. While the Advisory Council may well hold that it is premature to reach any firm conclusion as to the extent to which facilities for higher technological education should be supplemented, the qualification to its recommendation for the establishment of one or more colleges of applied science must not provide an excuse for indefinite postponement of this new experiment. Even if the new institutes of higher technology are established immediately, they cannot be expected to make an important contribution to higher technological education within much less than a decade. With the new demands on material and human resources, it is inconceivable that they will ever be established unless such resources are allotted to them as part of a considered distribution in which due, but not exclusive, regard is had to the competing demands of universities and industry and government departments.

On the government organisation for scientific research, besides the observations on the Department of Scientific and Industrial Research already considered (see *Nature*, September 9, p. 410), the Advisory Council states that a report received last November has fully confirmed the hopes entertained that the appointment of a chief scientist in the Ministry of Fuel and Power could make a valuable contribution to the discharge of the Minister's scientific responsibilities. The record of the first year of work of the new Division amply justifies the view that the Advisory Council took in its first annual report of the importance of creating a scientific division in executive departments with scientific responsibilities, and shows how much vitality is infused into research when its organisation and direction are planned in relation to the needs of potential users. The Advisory Council has also considered the organisation and needs of the Colonial Research Service, and particularly the comparative isolation in which members of this Service would inevitably work and the consequent difficulty which might be experienced in recruiting the best scientific workers for the posts. The Advisory Council feels strongly that the success of any scheme of research in the Colonies will depend upon the extent to which co-operation with the centres of research at home is made effective and the secondment is facilitated of members of the staffs of the research councils and the universities for periods of service in the Colonies.

In regard to co-operation between centres of research at home and overseas, it has been agreed with scientific representatives of the Colonial Office that before a research institution in the United Kingdom is asked to undertake work on behalf of the Colonies, the research council responsible for the institution would, wherever possible, be consulted. Provided overlapping and wasted effort is thus avoided, the Advisory Council sees great advantages in a continuing and increasing use by the Colonies of the facilities for agricultural research available in the United Kingdom. The organisation of ecological research was also considered, and the proposed programme of work of the Nature Conservancy has been discussed with its chairman, director-general and other members. The Advisory Council hopes that the establishment of the Nature Conservancy will encourage public recognition of the importance of ecology and create openings for trained ecologists. The responsibilities of the Conservancy are limited to Great Britain; but similar problems arise on a vast scale in other parts of the Commonwealth, and it is urgent to direct attention to the value of ecological work in the universities and elsewhere.

During the year the Council was consulted by the director of the Scottish Seaweed Research Association regarding a proposed attempt to introduce into British waters the type of foreign seaweed known as *Macrocystis*, in view of the comparative ease and economy with which it can be harvested compared with existing methods of harvesting the native *Laminaria*. A special committee, under the chairmanship of Sir Edward Salisbury, which was appointed by the Council, advised against the experiment on the grounds of risks to navigation and inshore fishing, and these conclusions were endorsed by the Council. The Council was also asked to examine existing departmental arrangements for controlling the use of potentially toxic substances or processes in the preparation of consumer goods, and appointed a special committee, with Prof. S. Zuckerman as chairman, for this purpose. Various problems relating to scientific work overseas, including the Technical Aid Programme, were also handled by the Advisory Council.

PHYSICS AT LIVERPOOL

THE Physical Society's summer provincial meeting was held at Liverpool on July 7 and 8 under the chairmanship of Prof. R. E. Peierls. The meeting gave speakers from the Experimental and Theoretical Physics Departments of the University an opportunity of presenting to members of the Physical Society and other visitors a picture of the work being carried on there in two main fields: nuclear physics, experimental and theoretical, on one hand; and the theory of the motion of electrons in solids, on the other. Contributions to the discussion from members of the audience provided many valuable comments and suggestions, and in some instances made known investigations on similar or allied lines being pursued elsewhere.

The meeting commenced with papers on the theory of solids. Recent developments arising from the work which Prof. H. Fröhlich and his collaborators, associated with the British Electrical and Allied Industries Research Association, have been pursuing over a number of years, on the interaction of moving electrons with the lattice vibrations in a solid, were surveyed by Prof. Fröhlich himself and Dr. H. Pelzer. The latter dealt mainly with conduction electrons in dielectrics, using a classical model for illustration. The excitation of lattice vibrations by the field of an electron moving in a known path can be calculated, the polarization being found at every point. Dr. Pelzer showed how the resulting rate of loss of energy by the electron can be evaluated as the total polarization energy produced in a layer of the medium lying far behind the electron and normal to its path, and of thickness numerically equal to the speed of the electron. A formula has been obtained[1] which is similar to one derived differently by A. Bohr. Also, the self-energy of the electron due to the interaction can be calculated, by integrating the interaction-energy density in the field over all space. This energy can be used to define an effective interaction mass, to be added to the ordinary mass of the electron. The interaction mass is proportional to the inverse cube of the velocity, and so diverges at zero velocity. However, a quantal theory would be expected to remove this divergence, owing to the diffuseness of the wave representing the electron. Dr. Pelzer referred briefly to a completely quantal treatment of the problem by Fröhlich, Pelzer and Zienau[2]. This permits recalculation of the quantities previously obtained classically. The total effective mass of the electron turns out at low velocity to be very little greater than the ordinary mass. This was put forward as an argument against the Landau concept of self-trapping of an electron. Finally, Dr. Pelzer pointed out that in ionic and non-polar crystals, notably semiconductors, free electrons acting as intermediary agents could lead to absorption of electromagnetic radiation by the longitudinal lattice vibrations, although this is normally forbidden.

Prof. H. Fröhlich explained how the application to metals of such considerations of the interaction between electrons and the lattice vibrations has led him to a theory of superconductivity. He claimed that the problem of finding a mechanism which can separate two distinct states, the normal and the superconducting, by an energy of the known extremely small magnitude, is thus solved. However, the electromagnetic properties of the superconducting state have not yet been fully investigated. The calculations adopt the simple Fermi gas model for the unperturbed motion of the electrons, while the lattice vibrations are handled by methods familiar in quantum field theory. Interaction results in the excitation of virtual vibration quanta by the electrons. This can be considered as producing self-energy of the electron gas, which is calculated by the second-order perturbation method. Part of the self-energy is expressible as an interaction energy between pairs of elements of the cloud of electrons in momentum space. At absolute zero the distribution in this space should ideally be chosen to minimize the energy: some distortion of the Fermi sphere would in general be expected. Prof. Fröhlich has considered a family of distributions obtained by displacing outwards a thin shell of electrons from the Fermi surface. A minimum of total energy is obtained for a small displacement if a number F measuring the strength of the electron-lattice interaction is sufficiently large; but otherwise zero displacement gives the lowest energy. Superconductivity of the metal is identified with the condition of distorted ground-state, and its existence thus depends on F. This quantity can be estimated from the high-temperature conductivity. It is found to be of the required order of magnitude, and also its value for different metals seems to be roughly correlated in the correct way with the existence or otherwise of superconductivity. The properties of different isotopes of the same metal are simply related on this theory. Thus the superconductive transition temperature is inversely proportional to the square root of the isotopic weight. Recent experiments on mercury[3,4] have confirmed this dependence. In the discussion, Prof. R. E. Peierls expressed the opinion that the isotopic effect is strong evidence in favour of the theory; and he and others emphasized the desirability of carrying out experiments with more isotopes.

A paper by Dr. K. Huang dealt with the theory of F-centres, which are of particular interest as the implest example of impurity centres. They have een carefully investigated experimentally by Pohl and his collaborators, but the theoretical discussion f many aspects has hitherto been only qualitative nd tentative. Dr. Huang has set out to analyse more thoroughly two properties of F-centres, namely, (1) the shape of their absorption bands, which show roadening with rise of temperature, and (2) the hotoconductivity, which falls off very rapidly when the temperature drops below a certain point. Accepting the general ideas which have been put forward to account for these phenomena by way of the interaction of the F-centre electron with the lattice vibrations, Dr. Huang presented a quantitative development of the theory. He has calculated transition probabilities using wave functions for electron plus lattice, analogous to those of Born and Oppenheimer for molecules, and treating the lattice approximately as a dielectric continuum. Absorption spectra at different temperatures, which he has plotted with the assistance of Miss A. Rhys, were shown to fit measured curves closely. The treatment of photoconductivity was not described in detail, but evidence was presented of a broad agreement with experiment.

Dr. B. Szigeti discussed the dielectric and elastic properties of ionic crystals. He proposed a model which would be consistent with the observed dielectric constant and would also conform to the Cauchy relations between the elastic constants, and to a newly derived relation between the compressibility and absorption frequency. Both the relations mentioned are experimentally well fulfilled for alkali halides. The essential feature of the model proposed is to take into account the distortion of the electron cloud of the ions due to the short-range repulsive forces. In an elastic deformation conditions are such that, even when this distortion is admitted, the restoring forces are effectively central, so that the Cauchy relations hold. As indicated above, the model also leads to a satisfactory relation between the compressibility and the absorption frequency. In an electric field, the distortions caused by the repulsive forces explain qualitatively the deviation of the experimental value of the dielectric constant from the value obtained if the polarization is attributed to the Lorentz force only. The model, in contrast to previous ones, gives the correct sign for this deviation of the dielectric constant.

The meeting passed on to topics in experimental nuclear physics. Mr. D. G. E. Martin gave a brief summary of the technique of the magnetic spectrometer for the measurement of the energy and intensity of β- and γ-radiation. He pointed out the importance of careful design of the apertures inside the instrument, so as to ensure that the minimum area of the internal surfaces of the spectrometer box is exposed to the view of both the source and the detector. Where the β-particles enter the detector they usually have to penetrate a thin foil, and absorption and scattering in this foil can lead to serious distortion of the spectrum in the region of small energies. Thin foils of 'Zapon' have been used, supported on copper mesh; but this arrangement is not satisfactory at the larger energies because the β-particles begin to penetrate the copper. When two counters are used in a coincidence arrangement in order to reduce the background counting-rate due to γ-radiation, the loss in the counting-rate due to the window is much greater for a particular energy of the β-radiation, because a β-particle scattered through a small angle in the window may not reach the second counter. Distortion of the spectrum may be produced also by scattering from the foil carrying the source itself, or by self-absorption in the material of the source. For measurements at an energy of 5 keV., the total thickness of foil and source should be less than 5 μgm./cm.^{2}. Various methods were described for the preparation of such sources. Mr. Martin went on to discuss the different types of detector which can be used with a magnetic spectrometer, including the scintillation counter and the photographic emulsion. He then outlined the problems involved in the measurement of the intensity of γ-radiation and of internal conversion coefficients. The discussion was illustrated by reference to work done in the laboratory on the radiations from a thorium-active deposit[5,6].

Mr. B. Collinge gave an account of his work on the dead time of self-quenching counters. The limitations to the performance of self-quenching counters were briefly discussed, and the work of Simpson[7] and Hodson[8] on reducing the dead time of argon-alcohol counters was described. Their method is to attempt to collect the positive ions formed during the discharge on the central wire after each count. To do this, a circuit is used which switches the wire potential to a negative value with respect to the cathode for a few micro-seconds after each count. It was pointed out that there may be a different explanation of the reduction in dead times so obtained. Experimental evidence was given to show that a sudden reduction of the wire potential causes the ion sheath to be confined to the part of the counter wire close to the place where the particle has passed. The remainder of the wire, not being involved in the discharge, is sensitive to further ionizing events as soon as the wire potential is restored to the working value. By using a very short counter, so that localization of the discharge does not occur, it has been shown that a reduction in the dead time can also be achieved by ion collection in the way suggested by Simpson and Hodson. Results showing the effect of causing localization of the ion sheath on the dead time of a counter were presented. The dead time of a counter 30 cm. long was found to be 20 μsec. and independent of the counting-rate up to $1 \cdot 8 \times 10^6$ counts per minute.

Some recent work with the 37-in. cyclotron by Holt and Young and also by Hughes was described. This was concerned with the determination of the angular distribution of the disintegration particles from targets bombarded with deuterons of energy up to 8 MeV. In one investigation[9] a differential ionization chamber was used to detect protons from the reaction $^{27}\text{Al}(d,p)^{28}\text{Al}$. The protons from a target of aluminium foil emerged from the target chamber through a curved window of 'Cellophane'. Thus the angle between the detector and the beam of deuterons could be varied continuously from 25° to 145°. At each setting of the angle of the detector the spectrum of the protons was determined by the use of calibrated absorbers. The intensity of the protons belonging to a particular group was measured by finding the area beneath the peak in the spectrum belonging to that group. Results were shown for seven groups of protons and for bombarding energies of 4·6, 5·8 and 7·5 MeV. These indicate a general tendency for the intensity of the protons to increase towards the forward direction. In the case of the proton group of longest range, a number of maxima and minima occur in the curve showing the angular distribution. An extension of these experiments in which intensities could be measured at small angles indicates a large peak in the forward direction in the case of the group of longest range with a deuteron energy of 7·5 MeV. The intensity decreases by a factor of 30 between 0° and 25° in this particular case.

The angular distributions of the neutrons emitted from light elements bombarded with 8-MeV. deuterons have also been measured. A thick polythene layer proton recoil chamber was used to detect the neutrons. On account of the increase in sensitivity with increasing neutron energy, this method of detection gives more weight to the higher-energy neutron groups. In all cases the neutron distribution showed a pronounced forward maximum in intensity. The half-widths of the forward peaks were of the order of 30–40°, tending to decrease as the atomic number of the element increased. The forward neutron intensity also decreased as the atomic number increased, but not monotonically. In the cases of beryllium, lithium, magnesium and aluminium, there was evidence of a peak at a small angle to the forward direction, with actually a shallow minimum in the forward direction; this tendency became pronounced as the threshold on the detector was increased so as to limit detection to the highest energies. The forward neutron intensity was found to decrease by a factor of three, and the half-width to increase slightly for beryllium, magnesium and aluminium when the deuteron energy was lowered to 7·2 MeV. In the case of magnesium the distribution was isotropic at about 5·5 MeV. bombarding energy. Taken together, these results seem to provide strong evidence for a 'stripping' reaction, the deuteron being split up by the nuclear collision. This process would be expected to lead to a strong forward peak of either protons or neutrons, whereas the type of process involving an intermediate nuclear state would lead to a more or less isotropic distribution.

In the field of nuclear theory, Dr. R. Huby spoke on certain nuclear reactions which are supposed to proceed by a direct transition from initial to final state, without the intermediate formation of a compound nucleus, as in the Bohr theory. Direct processes were expected often to be distinguished by a forward maximum in the angular distribution of the emitted particles. As an example, he discussed calculations by A. B. Bhatia and K. Huang to account for the above-mentioned (d,p) and (d,n) observations by Holt and Young, and Hughes. By handling a modified 'stripping' process with the Born approximation, an angular distribution is obtained having roughly the correct forward maximum. In the discussion, Prof. Peierls referred to calculations made on the same problem at Birmingham, which lead to apparently similar results by a rather different technique. Another direct process mentioned by Dr. Huby was the inelastic scattering of charged particles by nuclei, owing to the electrostatic interaction. He and Mr. H. C. Newns obtain a formula which predicts cross-sections up to about 10^{-26} cm.^{2} for excitation of a single level, and which is in approximate agreement with certain experiments.

Two speakers dealt with the nuclear explosions occurring when a fast particle passes through, or a meson is absorbed by, a nucleus. Dr. K. J. Le Couteur spoke on his work relating particularly to heavy nuclei, for which the Bohr statistical model is assumed to be applicable, and Miss S. N. Ruddlesden on her and Mr. A. C. Clark's study of meson absorption by light nuclei, taking account of the initial configuration of the constituent nucleons in the nucleus. Dr. Le Couteur considered the relatively slow charged nuclear particles ejected in explosions. These are supposed to be evaporated from the excited nucleus, in a process which can be dealt with thermodynamically. Their statistical distribution can be calculated for given excitation energy of the nucleus. Simple approximate expressions have been obtained for (i) the mean energy of the charged particles as function of the excitation energy, (ii) the relation between their mean number and mean energy, (iii) the relation between the standard deviation of the number and that of the energy. The fluctuations in the number are sufficiently small for this alone to give a good indication of the excitation energy. The calculations of negative meson capture by light nuclei, reported on by Miss Ruddlesden, lead to the relative probabilities of different modes of disintegration of the nucleus, and also to the energy spectrum of the charged particles ejected. Two types of meson-nuclear interaction have been considered. The lightest nuclei producing charged particles, namely, helium-3 and -4, were dealt with first, and later carbon and other α-particle nuclei. The energy spectrum of α-particles issuing from carbon can be made to agree quite well with experimental results from Bristol[10], by adjustment of one available parameter.

The final afternoon of the meeting was occupied with an inspection of the new Nuclear Physics Laboratory and the George Holt Physics Laboratory, after an introductory talk by Prof. H. W. B. Skinner on the layout and purpose of the former. He stated that the new Laboratory has been designed to accommodate two particle accelerators, a large synchro-cyclotron and a Cockcroft–Walton generator. Started in the middle of 1948, the main part of the building was completed by the end of 1949. It is hoped that the large cyclotron will be running by the end of 1951. The one-million-volt high-tension set which is now nearly complete follows conventional design. Two new features are incorporated: the ion source is of the radio-frequency type suggested by Thonemann, and the magnet used to deflect the beam through 90° is of the permanent type. This has a motor-driven shunt which enables the magnetic field to be varied between zero and a maximum of 10,000 gauss. The synchro-cyclotron is designed to accelerate protons to an energy of 400 MeV. The electromagnet has poles 156 in. in diameter and contains 1,640 tons of steel, which have already been delivered. The two energizing coils are wound from 1½-in. square-section aluminium and are cooled by passing water through a ⅝-in. diameter hole in the centre of the conductor. The coils weigh 30 tons each. The magnet will produce a field of at least 18,000 gauss at an input power of 840 kW. The cyclotron is surrounded by a concrete wall 6 ft. thick. Additional screening is effected by means of a bank of pulverized sandstone 15 ft. thick. A concrete wall of at least 12 ft. effective thickness, part of which will be constructed in removable blocks of loaded concrete, will separate the cyclotron from the experimental room. Easy access will be provided by means of a 30-ton cylindrical door which may be raised or lowered as required. Above the cyclotron room and separated from it by a concrete roof 5 ft. thick is the equipment room which will house most of the auxiliary gear. The control room will be situated in the main laboratory block.

R. HUBY

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ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT

THE report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, presented at the annual visitation of the Royal Observatory, held on June 3, refers to the period from May 1, 1949 to April 30, 1950, and exhibits the state of the Observatory on the latter date. Although a certain amount of progress has been made, things are still far from satisfactory, and the public should realize the serious difficulties under which the Royal Greenwich Observatory is struggling at present.

The temporary repair to the two large domes by placing tarpaulin inside them is only a partial success, and rainwater is able to percolate. The famous Octagon Room, Flamsteed's observatory, is without glass and requires a considerable amount of internal repair; meanwhile, further deterioration is taking place in historic buildings—a condition of affairs which has given rise to much adverse comment. Equally unsatisfactory are the housing conditions for the staff at Herstmonceux. Although the council houses made available through the Ministry of Health are sufficient for the needs of the junior and industrial staff, they are unsuitable for the senior staff, and the lack of houses for the latter is a serious handicap to recruitment for senior grades. It is pointed out that the only solution is for the Admiralty to build houses which are suitable to the status of the officers concerned. The proposal has been made to the Admiralty that houses should be built for the senior observing staff, who could thus reside fairly close to the Observatory; but unfortunately no decision has yet been given on the proposal. This is a matter of grave urgency, and, unless it is attended to forthwith, the work of the Royal Greenwich Observatory will be very seriously handicapped.

In addition to these drawbacks to the personnel, there is great disappointment at the slow rate of progress in the construction of new buildings for the instruments at Herstmonceux, and delays in this work are partly due to the remarkable decision that detailed requirements for every new building must be known before the construction of one of them can be commenced. A ray of hope illuminates a doubtful future—if these delays are not cumulative in their effect and if the new construction (when it commences) is sufficiently accelerated, the whole of the removal to the new site will be completed by the end of 1953.

Among a number of satisfactory features may be mentioned the move of the Solar Department and also, in part, the section of the Magnetic and Meteorological Department which was at Greenwich, and of the Nautical Almanac Office from Bath. The adaptation of the Great Hall of the Castle as a library is making good progress, and the conversion of the permanent chronometer rating and storage rooms under the Great Hall has been completed, the rooms now being in use.

It is impossible in the limited space available here to deal in detail with the report, which should be read by all who are interested in the future of the Royal Greenwich Observatory, and many will be specially interested in the plans for the installation of the Meridian Group and also the Equatorial Group. The latter will have three isolated domes for the 26-in., 28-in. and astrographic refractors, a three-dome building being in front of them to take the

30-in. and 36-in. reflectors as well as a Schmidt camera of 25–38 in., together with an aluminizing room and plant, and various other equipments. The aluminizing plant will be able to deal with the three main mirrors and, in addition, will serve as a pilot-model for the large reflector that will be later required for the Isaac Newton Observatory.

One point which is of special interest is the annual variation in the rotation of the earth, and this is dealt with under "Time Service". The rotation is such that the earth is slow in the spring and fast in the autumn, relative to the uniform time, by about 0·06 sec.; this subject is dealt with very fully by H. F. Finch[1]. The amplitude appears to be practically constant from year to year, and corrections for the effect are being made in the retrospective assessment of clock performance and also in the prediction of clock error and rate for the current operation of the time service.

In spite of the delay in the removal of the Observatory to Herstmonceux, perhaps its completion by the end of 1953, considering the international situation, will be accepted as something for which astronomers may, after all, be grateful.

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SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1948-49

THE fourth annual report of the South African Council for Scientific and Industrial Research* covers the year ending October 5, 1949, and includes the balance sheet and income and expenditure statement for the financial year ending March 31, 1949. While the buildings in which the headquarters staff and library and the national research laboratories for physics, chemistry and building have been housed during the past four years have been adapted to provide reasonably good facilities, the Council has now drawn up preliminary plans and estimates for a permanent building on a site offered by the University of Pretoria on its experimental farm.

Forty-three investigations, on contract, mainly industrial research, were completed during the year, and the system of industrial research fellowships has received further support. In addition to two research fellowships on lightning problems, two fellowships for the chemistry of wool and its by-products are being provided by the South African Wool Board. The Council also assisted in the incorporation of the Paint Industries Research Institute and the Sugar Milling Research Institute, and has discussed with the South African Wool Board the establishment of a wool textile research institute under its research association scheme. Satisfactory progress is also reported by the Fishing Industry Research Institute and the Leather Industries Research Institute. Of £46,130 provided by the Council for research workers in the universities and medical research units, £18,680 was for research in clinical medicine and surgery.

Special stress is laid in the report on the importance of the medical research units. Such units have been developed for research on tuberculosis, amœbiasis, bilharziasis and tropical diseases, nutrition, virus diseases, social medicine and cardio-pulmonary disease. A subcommittee of the Medical Research Committee advises the Council on the medical applications of radioisotopes, and the new new drugs, 'Miracil D' and 'aureomycin', have received attention from the Bilharziasis and Amœbiasis Research Units, respectively. The Library and Information Division continues to be handicapped by lack of sets of standard scientific periodicals. A special member of the staff has now been appointed to deal with requests for information, and the Division has also compiled a list of translators for scientific and technical work and organised a second one-day school of library methods for workers in small technical libraries.

The work of the National Building Research Institute has centred on four major problems to the solution of which all the more fundamental investigations have been directed. These are the provision of urban housing for Africans, building on the desiccated clay soils of the high veldt, the gain and loss of heat in buildings under high-insulation conditions, and problems associated with the use of high-magnesium limes. In the National Chemical Research Laboratory a study has been made of the constitution of South African clays, especially those being used to replace bentonite in foundry sands, of the dissolution of Transvaal chromite in sulphuric acid and the electro-winning of chromium, the colorimetric determination of citric acid with the Spekker absorptiometer, the submerged production of citric acid and the application of the anaerobic or methane fermentation process to the purification of molasses fermentation and wine distillation residues. Field research work carried out by the National Institute for Personnel Research has further increased, and much time has been given to research and routine testing on behalf of the Department of Defence. A Psychophysiological Research Unit was formed during the year, and the Statistical Section has worked out a new method of calculating standard scores which is applicable even to grossly abnormal distributions.

Most of the sections of the National Physical Laboratory are now well equipped and are capable of carrying out both applied and fundamental research. In the Electrotechnology and Electronics Division an instrument was developed for measuring and recording the thermocouple voltages generated in the differential thermal analysis of clays and the sine-wave generator brought to completion, while the construction of a saturated-diode transfer standard is nearly completed and a quantometer is being developed for use in spectro-chemical work. The Physics of Matter Division is developing a scintillation assay meter for the assay of uranium oxide in acid solution; a kevatron particle accelerator is receiving a trial run, and an X-ray spectrometer has been modified and fitted with a new slit-system to handle clay minerals with large basal spacings. A high-temperature camera has been designed and built, and a recording spectrophotometer installed. Considerable attention has been given to lens designing. The Telecommunications Research Laboratory has concentrated increasingly on the factors affecting radio-wave propagation in southern Africa, including the ionosphere, radio noise-levels and the physical constants of the ground. Other work includes the development of a high-performance communications receiver on a new principle, the development of an automatic weather station, the study of thunderstorms by radar and lightning research.

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* South African Council for Scientific and Industrial Research. Fourth Annual Report, 1948–1949. Pp. 84 + 7 plates. (Pretoria: South African Council for Scientific and Industrial Research, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Reported Photosynthesis *in vitro*

NUMEROUS attempts to achieve a photo-sensitized reduction of carbon dioxide by water *in vitro* are on record[1]. Various degrees of success have been claimed; but in almost every case the repetition of such experiments in other laboratories has failed and, in any event, the yields originally reported were extremely small. A significant advance, however, appeared to have been made in 1943 by Baur and his co-workers[2]. After many years of experimentation, Baur developed a two-phase system consisting of glycerol, geraniol, chlorophyll and methylene blue, which on illumination in a carbon dioxide atmosphere was stated to produce formaldehyde and oxygen in a photochemical yield amounting to about 5 per cent of that of natural photosynthesis. Although it is now known that formaldehyde is not an intermediate in natural photosynthesis, the realization of a photo-sensitized hydrogen-transfer reaction between carbon dioxide and water outside the living cell would be a result of great significance, and a confirmation of Baur's results, which have been widely quoted, therefore appeared desirable.

The experimental details given in Baur and Niggli's paper are not precise, but an attempt has been made to reproduce the conditions as closely as possible. Our reaction mixture consisted of 30 ml. of glycerol, 15 ml. of geraniol, 30 mgm. of crystalline chlorophyll and 18 mgm. of methylene blue. Baur and Niggli make no reference to the provision of water in their system, and it must be presumed that they relied on the water content of commercial glycerol. Our own sample of glycerol contained 1 per cent w/v of water as determined by titration with Karl Fischer reagent. Since commercial geraniol contains an appreciable proportion of aldehydic material, particularly citral, which is difficult to remove by fractionation and might interfere in the detection of formaldehyde, an aldehyde-free sample was prepared by suitable treatment with lithium aluminium hydride[3]. (The geraniol sample obtained after distillation had n_D^{19} 1·4758. Barnard *et al.*[4] give n_D^{14} 1·4782 for a sample purified through the calcium chloride adduct.) The reaction mixture was placed in a water-jacketed cylindrical 'Pyrex' glass vessel connected to a 1·5-litre gas reservoir and to an all-glass electromagnetic circulating pump. The apparatus was several times evacuated to a pressure of 1 mm. of mercury, and filled with pure carbon dioxide obtained by heating sodium bicarbonate. The cylindrical vessel was then agitated mechanically and lluminated for 24 hours with two 300-watt bulbs provided with metallic reflectors. At the end of this period, the emulsion was extracted with 60 ml. of water and the aqueous layer was treated with charcoal and filtered to give a colourless solution.

In agreement with Baur and Niggli, this filtrate gave a positive result with ordinary Schiff's reagent, and omparison with dilute aqueous formaldehyde solutions treated in the same manner showed that the intensity of the violet coloration corresponded to the resence of about 2 mgm. of formaldehyde in the aqueous extract. However, in contrast to the authentic formaldehyde solutions, the aqueous extract failed to give a positive result with strongly acid Schiff's reagent[4] or in the chromotropic acid test[4]. Furthermore, the aqueous extract yielded a 2 : 4-dinitrophenylhydrazone which could not be completely purified, but which showed an ultra-violet absorption maximum at considerably longer wavelengths (λ_{max} 3680 A. in chloroform solution) than the formaldehyde derivative (λ_{max} 3480 A.)[5]. Baur and Niggli, on the other hand, state that they identified formaldehyde as the dimedone derivative, the melting point of which is not reported.

Although the aldehydic material formed in our experiment is clearly not formaldehyde, it seemed possible that it was perhaps a condensation product of the latter ultimately derived from carbon dioxide. The experiment was therefore repeated in an atmosphere of helium instead of carbon dioxide, under otherwise identical conditions, and the aqueous extract was submitted to the same tests as previously. The results again indicated the formation of an aldehyde other than formaldehyde and in nearly the same quantity as before. It may be concluded that, whatever the nature of the aldehydic product formed in the first experiment, it was not derived from the carbon dioxide but from another component of the reaction mixture. There is therefore no evidence for the occurrence of photosensitized reduction of carbon dioxide in our experiments.

We thank Monsanto Chemicals, Ltd., for a research award to one of us (C. J. T.).

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Uracil Deoxyriboside

DURING the isolation of the deoxyribosides of guanine, hypoxanthine, thymine and cytosine from an enzymatic hydrolysate of a commercial preparation of herring sperm deoxyribonucleic acid (Isaac Spencer and Co., Ltd., Aberdeen), a fifth compound was obtained and identified as uracil deoxyriboside.

The new compound was initially found as a contaminant of thymidine isolated according to the method of Brown and Lythgoe[1]. It was tentatively identified on a paper chromatogram by its R_F value (the pyrimidine deoxyribosides have been found to have the same R_F values as their component pyrimidine bases when run on a paper chromatogram with a butanol : water (86 : 14) solvent) and by the slow development of a blue colour when treated with Dische's reagent[2]. Since the occurrence of the uracil deoxyriboside coincided with a marked decrease in the recovery of cytosine deoxyriboside, it was assumed that deamination of the latter compound had taken place, probably by enzymatic hydrolysis. Unequivocal proof that the uracil deoxyriboside had not been present as a constituent of the intact deoxyribonucleic acid was obtained when formic acid hydrolysis of the deoxyribonucleic acid[3] and subsequent chromatography of the hydrolysate demonstrated the absence of uracil. The failure to find this new deoxyriboside in either previous or subsequent identically conducted isolation experiments obviated the supposition that one of the enzyme preparations used in the degradation contained a cytosine deoxyriboside deaminase. It was therefore concluded that bacterial contamination had occurred during the preparation by a micro-organism possessing an enzyme capable of deaminating cytosine deoxyriboside. Such an enzyme has recently been found to occur in extracts of cells of a certain strain of *E. coli*[4].

The impure thymidine containing the uracil deoxyriboside was partitioned on a powdered cellulose column using butanol – water. Although this gave a complete separation of the two deoxyribosides, the uracil deoxyriboside thus obtained was still contaminated with 5–10 per cent of uracil. The presence of the latter substance was also noted by Wang *et al.*[4], who found, by means of spectrophotometric measurements, that uracil as well as uracil deoxyriboside was formed when cytosine deoxyriboside was treated with their bacterial cell extract. The uracil, which could not be removed by recrystallization from 90 per cent ethanol, was completely separated from its deoxyriboside by chromatography on a cellulose column with *tert.*-butanol : pyridine : water (65 : 25 : 15). The new deoxyriboside, after recrystallization from 95 per cent ethanol, gave needles or clusters of small needles, melting point 163° (found : C, 47·0 ; H, 5·3 ; N, 12·6. $C_9H_{12}N_2O_5$ requires C, 47·3 ; H, 5·3 ; N, 12·3 per cent). $[\alpha]_D^{22} + 50°$ ($\pm$ 2°) (*c*, 1·1 in *N* NaOH). The solubility of uracil deoxyriboside in water and alcohol is very similar to that of thymidine. The ratio, R_F uracil deoxyriboside/R_F thymidine, is 0·74 in butanol : water (86 : 14), 0·94 in *iso*propanol : 2*N* hydrochloric acid (65 : 35), 0·94 in *tert.*-butanol : pyridine : water (60 : 25 : 15), and 0·83 in butanol : acetic acid : water (20 : 5 : 25). Formic acid hydrolysis of the deoxyriboside and paper chromatography of the hydrolysate in several different solvents gave, in each case, only one ultra-violet absorbing spot[5] having an R_F value identical with that of uracil.

A second commercial preparation of deoxyribonucleic acid (Schwarz Laboratories, Inc., New York), which on formic acid hydrolysis produced a considerable amount of uracil[6], was found to contain uracil deoxyriboside after enzymatic hydrolysis. Paper chromatography of a 95 per cent ethanol extract of the lyophilized enzymatic hydrolysate gave three distinct spots with butanol : water. The slowest-moving spot proved to be primarily cytosine deoxyriboside with traces of guanine and hypoxanthine deoxyribosides. Smith and Cuthbertson[7] have shown that these three deoxyribosides have very similar R_F values in water-saturated butanol. The fastest-moving component proved to be thymidine, and the intermediate spot was uracil deoxyriboside plus a small amount of adenine deoxyriboside. This latter fact was demonstrated by paper chromatography of the middle component using *iso*propanol : 2*N* hydrochloric acid (65 : 35). The uracil deoxyriboside was separated as before, and was shown to have the same R_F value in *iso*propanol : 2*N* hydrochloric acid as the compound obtained from the bacterially contaminated hydrolysate of herring sperm deoxyribonucleic acid and as the product of nitrous acid deamination of cytosine deoxyriboside. In view of the absence of uracil in the large number of specimens of deoxyribonucleic acid analysed by Chargaff and co-workers[8-10] and by Wyatt[11], it is believed that the uracil present in this deoxyribonucleic acid was formed from cytosine in the course of the preparation of the commercial product. Confirmation of this partial degradation was found in the low yields of cytosine obtained on formic acid hydrolysis and in the incomplete hydrolysis (60 per cent) of the preparation when treated with deoxyribonuclease and nucleophosphatase.

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Autoxidation of Oleic (or Other Mono-ethenoid Long-Chain) Esters

IT is generally accepted that autoxidation of unsaturated fatty compounds at ordinary temperatures is an action propagated by a free-radical mechanism. The radicals concerned have been shown to be derived from the α-methylenic groups adjacent to a double bond. From consideration of chemical and kinetic evidence Bolland[1] has concluded that the chain propagation reactions involved are

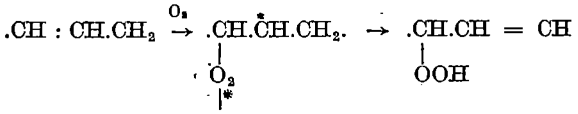
$$RO_2— + RH \rightarrow R.OOH + R— \text{ and } R— + O_2 \rightarrow RO_2—,$$

where *R*H is an unsaturated fatty ester, and *R*— is a free radical of the formula $R'.\overset{*}{C}H.CH = CH.R''$.

The *initiation*, as distinct from *propagation*, of the autoxidation reaction has been the subject of some discussion ; but Farmer[2] considered that "there is perhaps good justification for postulating universal *initiation* of autoxidative attack in all the various kinds of olefinic systems by *addition* occurring at double bond centres", for example,

$$.CH_2.CH : CH. \xrightarrow{O_2} .CH_2.\overset{*}{C}H.CH(OO^*) \xrightarrow{.CH_2.CH\,:\,CH} CH_2.\overset{*}{C}H.CH(OOH) + .\overset{*}{C}H.CH = CH.$$

Gunstone and Hilditch[3] concurrently put forward the view that initial interaction between oxygen and an ethenoid bond is more likely than direct initial hydroperoxide formation at a methylene group ; initial loose attachment of oxygen at a double bond could result in migration of a hydrogen atom from an α-methylenic group with formation of a hydroperoxide and consequent 'displacement' of the double bond :



$$.CH : CH.CH_2 \xrightarrow{O_2} .\underset{\substack{|\\ O_2\\ |^*}}{CH}.\overset{*}{C}H.CH_2. \rightarrow .\underset{\substack{|\\ OOH}}{CH}.CH = CH$$

The object of this note is to suggest that, at ordinary temperatures, initiation of autoxidation is a function solely of long-chain unsaturated compounds which contain the pentadiene system $.CH : CH.CH_2.CH : CH.$, with a central reactive methylene group; and that the simple mono-ethenoid system $.CH_2.CH : CH.CH_2.$ is not susceptible to similar direct attack by oxygen at temperatures below about 50° C. (although at higher temperatures direct union between oxygen and a mono-ethenoid ester such as methyl oleate proceeds rapidly[4,5]).

Reasons for this conclusion are: (1) the marked resistance of the methyl oleate used by Gunstone and Hilditch[3,5] to autoxidation as compared with that used by previous workers; (2) the circumstance that the oleate used by Gunstone and Hilditch was prepared by new methods which ensured complete absence of linoleate, as shown by spectroscopic evidence; (3) and their observation[3] of the marked effect of very small proportions of added linoleate (1 per cent or less) in reducing the initial 'induction period' for this methyl oleate in diffused daylight at 20° by about 80 per cent (from about 800 hours to 150 hours).

On the other hand, the methyl oleate used by Atherton and Hilditch[4], and prepared by older methods, contained about 5 per cent or somewhat less of linoleate, and that employed by Farmer and Sutton[6] (probably also containing some linoleate), in the course of the isolation of methyl oleate peroxide, absorbed oxygen with relatively great rapidity at 35° with ultra-violet irradiation, the product after autoxidation for 4 hours containing 1·3 per cent of peroxide oxygen. It has since been found by Dunn and Riley (unpublished experiments from these laboratories) that the linoleic-free methyl oleate referred to above absorbs oxygen relatively very slowly at 20–25° when exposed to oxygen in the light of an ultra-violet lamp in the manner of Farmer and Sutton's autoxidations; moreover, the similar autoxidation of methyl ricinoleate or of methyl undecenoate (both of which are relatively easily freed from linoleic or other polyethenoid admixture) was found to be extremely slow.

Taken in conjunction, all these at first sight divergent observations suggest strongly that methyl oleate free from contamination with linoleate had not been employed in autoxidation studies prior to the experiments described by Gunstone and Hilditch; and that, to all intents and purposes, methyl oleate, when free from linoleate, does not undergo autoxidation at ordinary temperatures. Further, since it has been shown[3] that autoxidation of pure oleate can be readily induced in presence of a small proportion of linoleate, it is clear that, although initiation of the process does not take place with oleate alone, the chain reaction can be propagated freely so soon as active peroxide radicals, derived *initially* from linoleate, are present in sufficient amount.

The course of the oxidation of the oleate groups is thus conditioned solely by the chain propagation reaction, and may well, therefore, be exclusively that of the formation of hydroperoxide groups at the α-methylenic groups adjacent to the double bond:

$$.CH_2.CH : CH.CH_2. + R.OO \rightarrow .CH_2.CH : CH.CH(OOH). + R—$$

(where RH is initially methyl linoleate, but may afterwards also be methyl oleate).

It has seemed appropriate to direct attention to these features in previously recorded autoxidation studies of methyl oleate, since the explanation now offered not only clarifies somewhat divergent observations, but also points to a major difference in behaviour to oxygen (as might be expected) between the isolated mono-ethenoid system $—CH_2.CH:CH.CH_2—$ and the pentadiene grouping $—CH:CH.CH_2.CH:CH—$ with its 'reactive' central methylene group.

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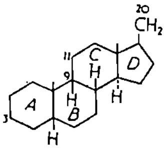
Structure of Uranediol

MARKER and his colleagues[1] isolated in 1938 from the urine of pregnant mares two compounds, uranediol ($C_{21}H_{36}O_2$) and uranetriol ($C_{21}H_{36}O_3$), which were derivatives of a hydrocarbon urane, isomeric with pregnane and apparently steroid in character. Uranediol has since been isolated from pregnant mare's urine by Bauld and Heard[2] and by Klyne[3].

Marker[1b,c] suggested that urane was 9-*iso*-pregnane (I) and that the hydroxyl groups of the diol and triol were at positions 3 and 11, and 3, 11 and 20 respectively, but was unable to prove these hypothetical structures. The compounds are of interest since they are the only naturally occurring steroids for which a *cis* union of rings *B* and *C* has been postulated, except for sarmentogenin, now known to have the usual *trans B*/*C* fusion[4].

It has now been shown that uranediol also has the usual *trans B*/*C* fusion, but is a *D*-homosteroid. It appears to be the first such compound of natural origin to be isolated.



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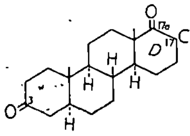

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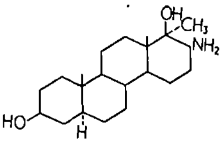

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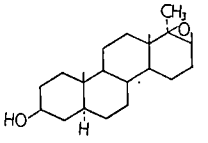

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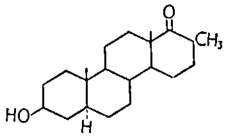

V

In June 1949 it occurred to me that the properties of the urane compounds could best be accounted for by their formulation as 17-methyl-*D*-homoandrostane derivatives, uranedione being the 3 : 17α-diketone (II). This formula accounts for the molecular rotation[3], infra-red absorption[5] and the presence of one hindered keto group which does not form a semicarbazone[1c,3]. Attempts to synthesize the structure II were begun.

Recently, I noticed that a compound "XI", $C_{21}H_{34}O_2$ (obtained by Prins and Shoppee[6] by treatment of the amine III with nitrous acid, and formulated by them as the epoxide IV because it did not react with Girard's reagent *T*), resembled closely Marker's uran-3-ol-11-one[1d]. The properties of Prins and Shoppee's compound "XI" seemed compatible with its formulation as a hindered ketone V. If this idea and the previous hypothesis regarding urane compounds were correct, oxidation of "XI" with chromium trioxide should give uranedione (II).

Prof. C. W. Shoppee very generously gave me 20 mgm. of the compound "XI", which was oxidized with chromium trioxide in glacial acetic acid at room temperature. The product was identical with uranedione obtained by oxidation of uranediol[3], as shown in the accompanying table.

COMPARISON OF THE OXIDATION PRODUCT OF COMPOUND "XI" AND URANEDIONE

	Oxidation product of compound "XI"		Uranedione
M.p.*	173–176°		171–174°
Mixed m.p.		174–176°	
$[\alpha]_D$ in chloroform	−23·0 ± 1·0°		−21·3 ± 0·9°
Semicarbazone, m.p.	221–224°		223–227°
Semicarbazone, mixed m.p.		221–225°	
Semicarbazone, N content†	11·0 per cent		12·1 per cent

* All melting points are corrected. The semicarbazone melts with decomposition.

† A monosemicarbazone requires N 11·2 per cent; a disemicarbazone requires N 19·5 per cent.

The presence of a keto-group in Shoppee's compound "XI" was confirmed by the ultra-violet absorption spectrum, which showed a low maximum at 290 mμ.

From the evidence given above it is clear that compound "XI" is, in fact, a hindered ketone and can only have the formula V. Uranedione must therefore be II. Attempts to synthesize II by an independent route are being continued.

Since uranedione is stable to acid[3], the methyl group at C-17 is presumably in the stable equatorial position, 17α (cf. Barton[7]). Since uranediol can be precipitated by digitonin, the hydroxyl group at C-3 is most probably β-oriented. Uranediol is therefore a 17-methyl-*D*-homoandrostane-3 : 17α-diol, most probably a 17α-methyl-3β-hydroxy isomer, the orientation of the 17α hydroxyl being unknown.

Since uranediol has been isolated[3] from mare's urine as its sulphuric acid ester by relatively mild procedures, it seems unlikely that it is an artefact. (Contrast the *D*-homosteroid obtained by Hirschmann and Hirschmann[8] from the urine of a boy with adrenal carcinoma; these authors state that the *D*-homo compound was probably produced by rearrangement during the fractionation of the extract.) Uranediol appears, therefore, to be the first *D*-homosteroid of natural origin to be isolated.

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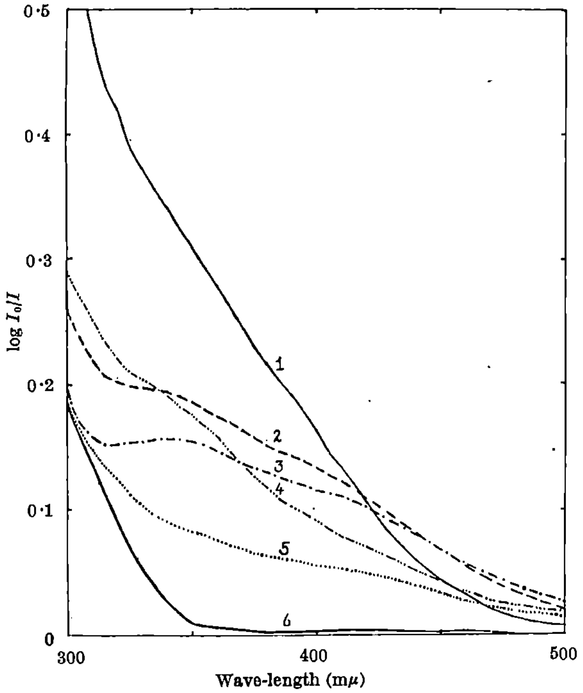
Absorption Spectra of the Sodium Peruranates

IT was shown by Scott[1] that the presence of bicarbonate in solutions of sodium peruranate, formed by the addition of excess hydrogen peroxide to sodium uranyl tricarbonate solution, caused errors in the absorptiometric determination of uranium. Smales and Furby[2] found the optical density to be dependent on both the *p*H and the carbonate content of the solutions. A study of the absorption spectra of these solutions, using the Beckmann spectrophotometer, confirms the theory of Scott that the colour change is due to the formation of a series of peruranates, and suggests that his alternative mechanism, the formation of sodium uranyl tricarbonate as a result of the action of sodium bicarbonate, is less important.

When uranium dioxide is shaken with an excess of sodium carbonate solution in the presence of hydrogen peroxide, the maximum quantity dissolved is 0·33 mol. UO_2/mol. H_2O_2. This observation suggests the formation of Na_2UO_6, as the predominating constituent of the solution, by the reaction:

$$UO_2 + 3H_2O_2 + 2Na_2CO_3 = Na_2UO_6 + 2H_2O + 2NaHCO_3.$$

The addition of excess sodium hydroxide and hydrogen peroxide to the solution results, after concentration and cooling, in the formation of orange-red needle crystals which have been shown to be sodium peruranate, $Na_4UO_8.8H_2O$. This compound is apparently identical with those prepared by Fairley[3], and by Rosenheim and Daehr[4]. Curves 1, 2, 3 and 4 are typical of the absorption spectra of solutions of uranium trioxide in (1) sodium carbonate and excess sodium hydroxide, (2) sodium carbonate, (3) equal quantities of sodium carbonate and sodium bicarbonate, and (4) sodium bicarbonate, a large excess of hydrogen peroxide being present in each case. Curve 1 thus represents the absorption spectrum of a solution in which Na_4UO_8 predominates. Curves 2 and 3 are progressively less steep than curve 1, the density increasing in the region 420–500 mμ, although sodium uranyl tricarbonate solution (curve 6) shows little absorption in this region. Solutions 2 and 3 must therefore contain peruranates lower than Na_4UO_8, the observation on the solution of uranium dioxide suggesting that these solutions contain high proportions of Na_2UO_6. The further addition of sodium bicarbonate causes a reversal of the trend shown by curves 2 and 3, curve 4 being steeper, and showing little trace of the absorption maximum at 340 mμ which appears to be characteristic of the compound Na_2UO_6. This curve must therefore represent the spectrum of a solution in which the lowest peruranate, considered by Rosenheim and Daehr to be $Na_2U_2O_{10}$, predominates. It would thus appear that the changes in the absorption spectra of sodium peruranate solutions containing varying proportions of sodium hydroxide, sodium carbonate and sodium bicarbonate, with excess hydrogen peroxide, are due largely to changes in proportion of the three peruranates, the effect of absorption by sodium uranyl tricarbonate being relatively unimportant.



UO_3 0·005 per cent w/v in all solutions. 1-cm. cells.
Curve 1. Na_2CO_3, 0·125 ; NaOH, 0·40 ; H_2O_2, 0·06% w/v.
Curve 2. Na_2CO_3, 0·125 ; H_2O_2, 0·06% w/v.
Curve 3. Na_2CO_3, 0·125 ; $NaHCO_3$, 0·125 ; H_2O_2, 0·06% w/v.
Curve 4. $NaHCO_3$, 0·125 ; H_2O_2, 0·06% w/v.
Curve 5. Na_2CO_3, 0·125 ; H_2O_2, 0·0003% w/v.
Curve 6. Na_2CO_3, 0·125% w/v.

This hypothesis is confirmed by a study of the spectrum of a solution of uranium trioxide in sodium carbonate, with insufficient hydrogen peroxide to form the lowest peruranate. The resulting curve curve 5), which is characteristic of a mixture of sodium uranyl tricarbonate and sodium peruranate, is intermediate in form between curves 3 and 6, and shows little resemblance to curve 4. Solution 4 cannot therefore contain a similar mixture, but must be composed largely of the lowest peruranate, $Na_2U_2O_{10}$.

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Nature of Specific Solvents for Bituminous Coals

In previous communications[1] it has been pointed out that certain liquids—termed specific solvents—possess a marked ability to dissolve bituminous coals of low rank at room temperature, a property not shared by other liquids ; furthermore, almost all liquids tested have been found to fall *definitely* into one or other of these classes. The principal specific solvents are primary aliphatic and certain heterocyclic amines.

A comparison of the solvent power data for more than a hundred substances has now shown that this property bears very little relation to the internal pressure, surface tension, dielectric constant or dipole moment of the solvent. The significance of the moderate correlation with internal pressure observed by Kiebler[2] has already been discussed[1] ; it is probable that it reflects conditions under which, owing to incipient pyrolysis of the coal, nearly all organic liquids are moderately effective 'solvents' and specific factors are less important.

At atmospheric temperature, on the contrary, the following rules have emerged. The specific solvent (for example, an aliphatic primary amine) contains a nitrogen or oxygen atom with an unshared pair of electrons. This electron pair, however, may be prevented from promoting solvent power by interfering influences : (1) by excessive hydrogen bonding, for example, in amines when diluted with water, or in ethylene glycol as contrasted with ethylene diamine ; and (2) by participation of the lone pair in resonance of the molecular nucleus, for example, in aniline and pyrrole as contrasted with benzylamine and pyridine. Other things being equal, nitrogen compounds are better solvents than compounds containing oxygen (compare the primary amines with alcohols, which are very weak in solvent power). Alkyl groups in themselves tend to reduce solvent power ; this can be seen from the fact that diethylamine is one of the most effective precipitants for removing coal extracts from solution in specific solvents, and is an important factor determining the lack of solvent power of secondary and tertiary aliphatic amines. The inability of secondary and tertiary amines to swell coal remains to be explained. The adverse effect of alkyl groups in primary aliphatic amines is insufficient to remove these from the ranks of specific solvents ; when comparison is made with primary aromatic amines, in which the adverse influence of resonance is pronounced, alkyl groups therefore appear at first sight to promote activity. Solvent power is further modified by such factors as molecular size, viscosity, and by inductive effects which influence the availability of the unshared pair.

It is perhaps worth while emphasizing the contrast between the behaviour of solvents towards an 'aged' or compacted gel system such as coal[3] (in which the primary function of a solvent must be to swell and so loosen the structure), and towards such natural and synthetic polymers as have not been subjected to comparable treatment ; and also between systems (for example, coal and amines) in which specific interaction occurs, and those (for example, rubber and benzene) at the opposite extreme, in which both compounds have a chemical similarity and interaction takes place through van der Waals forces. An appreciation of these differences serves to explain why many well-known relationships[4] and approximations[5] can have little relevance to the phenomena of coal solution.

SINCE the preceding was written, a paper by Dilke, Eley and Sheppard[6] on the mechanism of the Friedel–Crafts reaction has appeared, which raises further points of interest. These workers have used the heat of interaction of various amines with aluminium chloride as an approximate measure of the co-ordinate bond-energy. By this criterion, amines fall into the same relative order as that found when they are arranged according to their ability to swell and dissolve lower-rank bituminous coals, thus providing further confirmation of the conclusion that an electron-donor mechanism is involved in the interaction between these coals and amines. Particularly striking is the great difference between primary, secondary and tertiary aliphatic amines, which was also observed by Brown[7] in the case of their interaction with tributyl boron. Brown attributes this behaviour to steric interference between groups attached to the electron acceptor and to the donor respectively, emphasizing that the steric factor must involve a contribution from *both* sides[8]. The observations with coal therefore indicate that the electron acceptor on coal surfaces is surrounded by alkyl or other groups projecting from the surface. Inertness of secondary and tertiary aliphatic amines (as with coal) was observed by Brown[7] only when (the large) *butyl* groups were attached to the boron; but in this case ammonia was the most active base, whereas with coal it is not; trimethyl boron, on the other hand, removes ammonia to a lower position while retaining the same order for the amines, but secondary and tertiary amines in this case form weak addition compounds. A complete explanation of the results with coal is therefore not yet forthcoming.

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Hydrothermal Synthesis of Potash Feldspar in the Range 195–200° C.

CONSIDERABLE interest is attached to conditions under which syntheses of feldspars may be accomplished. A number of preparations have been described by high-temperature sintering[1–3], pneumatolytic[4], or pyrolytic[5] methods, and at lower temperatures by the hydrothermal procedure[6–8], the usual range of temperatures lying between 300° and 1,000° C. The lowest temperature previously recorded for such a synthesis has been 245° C. in the case of Gruner's formation of potash feldspar, by hydrothermal alteration of montmorillonite[9]. The reaction at this temperature was, however, very slow and required about six weeks.

We now record a synthesis of potash feldspar, which gave a high yield within sixteen hours in the temperature interval 195–200° C. Synthetic leucite ($KAlSi_2O_6$), sodium and potassium carbonates and water were mixed and introduced into a steel autoclave of 20 c.c. internal capacity. Sufficient of each salt was present to give a saturated solution and an excess of the solid salt. After heating at 195–200° C. for sixteen hours the product was transferred to a filter paper, washed thoroughly and dried at 90° C. The crystals were small, of refractive index 1·521, as with orthoclase, and gave good X-ray powder photographs identical with those from naturally occurring orthoclase and adularia. The accompanying figure shows a typical crystal, which is seen to be of a form characteristic of orthoclase.

Crystal of synthetic potash feldspar (× 1,400)

This formation represents a complete synthesis of potash feldspar, since the leucite was prepared from analcite ($NaAlSi_2O_6.H_2O$) and the analcite was grown directly from a hydrous sodium aluminosilicate gel of approximately analcite composition. The gel was made from 'Alfloc' ($NaAlO_2$ + some free alkali) and silicic acid gel free from entrained acid. It was crystallized hydrothermally at about 200° C., the reaction normally being completed overnight. The analcite was then treated hydrothermally at 150° C. with saturated potassium chloride (aq.) containing some solid potassium chloride crystals, four successive treatments being given. The analcite was in this way subjected to complete ion exchange to give synthetic leucite:

$$\underset{\text{Analcite}}{NaAlSi_2O_6.H_2O.} + K^{+}aq. \rightarrow \underset{\text{Leucite}}{KAlSi_2O_6} + Na^{+}aq. + H_2O$$

The leucite was then available for conversion t potash feldspar as described.

The conversion serves as a reminder that geo chemical processes often regarded as comparativel high-temperature ones can sometimes be easil accomplished in the laboratory under quite mil conditions. In this and probably in similar case one may extend geological experience by direc chemical methods.

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Rotation-Vibration Spectrum of the HD Molecule

As is well known, the hydrogen molecule (H_2) has no ordinary dipole infra-red spectrum. Its quadrupole rotation-vibration spectrum is exceedingly weak, and has only recently been found[1]. In the case of HD, on account of the asymmetry, there is no longer a distinction between symmetric and antisymmetric rotational levels, and a dipole rotation-vibration spectrum can occur at least in principle. However, the change of dipole moment associated with the vibration of HD is obviously very small. The main contribution to this change is due to the fact that the electrons lag slightly behind the nuclei during the vibrational motion. Wick[2] has calculated according to wave mechanics the intensity of the fundamental of HD. From his data it can be estimated that the minimum absorbing path required for an observation of the fundamental of HD is 30 m. atm. For the overtones, correspondingly longer path-lengths would be required.

With the technique of long optical paths recently developed[3], it appeared promising to attempt an observation of the HD spectrum in the photographic infra-red. A glass absorption tube 5 metres long was filled with HD of 1 atm. pressure. Using approximately 140 and 200 traversals, that is, absorbing paths of 700 and 1,000 metres, seven and six lines respectively were found of the 3–0 and 4–0 bands of HD (second and third overtone) near 9650 and 7400 A. The accompanying table lists the observed wave-numbers. Even with the long path used, the intensities of the HD lines are quite low. The over-all intensity of the 4–0 band of HD is lower than that of the 3–0 band by a factor of only 3 or 4. This is noteworthy, since for ordinary dipole vibration spectra the intensity ratio of the second and third overtone is of the order 30 or 40 (for example, for hydrogen chloride).

HD Absorption Lines

Designation		ν_{vac} (observed)	$o-c_1$	$o-c_2$
3–0	$R(0)$	10445·536	+ 5·325	−0·004
	$R(1)$	10511·488	+ 5·771	−0·009
	$R(2)$	10565·048	+ 6·474	+0·008
	$R(3)$	10605·764	+ 7·403	+0·010
	$P(1)$	10278·419	+ 5·091	−0·015
	$P(2)$	10178·467	+ 5·340	+0·015
	$P(3)$	10068·351	+ 5·748	−0·009
4–0	$R(0)$	13551·127	+ 7·118	+0·008
	$R(1)$	13609·745	+ 8·203	+0·006
	$R(2)$	13652·293	+ 9·813	−0·012
	$R(3)$	13678·435	+11·986	−0·003
	$P(1)$	13387·695	+ 6·575	+0·007
	$P(2)$	13284·020	+ 7·095	−0·012

The best available rotational and vibrational con-ants of HD in the ${}^1\Sigma^+$ ground-state are those lculated from the constants of H_2 by Jeppesen[4] nd Urey and Teal[5]. The constants obtained directly om the ultra-violet HD spectrum are less accurate ee Jeppesen[4]). Using Urey and Teal's constants, e positions of tho HD lines can be predicted. olumn 3 of the table gives the differences between ese predicted and the observed wave-numbers. It seen that there is a systematic difference, prin-pally due to the fact that the original H_2 constants om which the HD constants were calculated need vision[1]. The following rotational and vibrational nstants of HD were derived directly from the served wave-numbers combined with the Raman ta of Teal and MacWood[6]:

$$B_v = 45{\cdot}638_5 - 1{\cdot}9503(v+\tfrac{1}{2}) + 0{\cdot}0140_0\,(v+\tfrac{1}{2})^2.$$
$$D_v = 0{\cdot}02590 - 0{\cdot}00084(v+\tfrac{1}{2}) + 0{\cdot}00004_4\,(v+\tfrac{1}{2})^2.$$
$$G(v) = 3809{\cdot}7_{45}(v+\tfrac{1}{2}) - 89{\cdot}7668(v+\tfrac{1}{2})^2 + 0{\cdot}36567(v+\tfrac{1}{2})^3.$$

A value $H_v = 0{\cdot}0000219$ cm.$^{-1}$ was assumed. The differences between the observed wave-numbers and those calculated from the new constants are given in the last column of the table.

If a sufficient amount of hydrogen and deuterium were present in the atmospheres of the major planets, the 4–0 band of HD might be used for their detection[7]. However, this would require the highest possible resolution, because of the small width of these lines.

It is hoped to observe the fundamental and first overtone of HD in the near future with the aid of a new high-dispersion infra-red spectrometer which is being built in this laboratory.

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A New Type of X-Ray Scattering

Insulators are characterized by discrete allowed and forbidden zones having sufficient energy width. In diamond, theoretical calculation by Kimball[1] shows that the forbidden zone width is about 7 eV., which has been experimentally verified by the appearance of the ultra-violet absorption band[2] at 1700 A., that is, 7 eV. I have determined the forbidden zone widths in the case of the insulators aluminium oxide and silica from their soft X-ray absorption and valence emission spectra[3]. Skinner[4] has investigated beryllium, carbon and boron in the conducting state, as well as in the insulators beryllium oxide (BeO), diamond and boron trioxide[5]. Siegbahn[6] has investigated K_α of diamond, as well as that of graphite, the conducting variety. E. Guinner and H. Kiessig[7] have investigated K_α, that is, K valence band spectra of boron in the pure element, in various binary alloys and in boron trioxide, which is a typical insulator. I have investigated K valence band spectra of the insulators aluminium oxide and silica.

In all the elements beryllium, boron, carbon (graphite), silicon and aluminium and in all their conducting alloys, the long wave-length K valence band satellite is absent. But in typical insulators involving these elements, there appears a long wave-length satellite which is most prominent in the case of beryllium oxide, boron trioxide and diamond, for which the characteristic X-ray wave-lengths concerned are only the K_α-radiation of metal and of oxygen. The energy gap between the peak of the long wave-length satellite and the main K_α-band for these insulators agrees well with the energy difference between the peak of the valence emission band and the approximate centre of the first allowed vacant band obtained from the absorption data.

The explanation is as follows: K_α of beryllium, boron and carbon produced by electron impact within the sample of beryllium oxide, boron trioxide and diamond, while coming out of the thin layer of the insulator in the target, is partially absorbed by the valence electrons of the particular insulator. These electrons, after partial absorption of the incident K_α photon, jump into the first available vacant band of the insulator, and the incident K_α becomes degraded in energy value by the amount equivalent to the gap between the so-called centre of gravity (position of maximum energy density) of the filled valence band and the centre of the first allowed vacant band of the particular insulator. That there is appreciable target penetration in the case of such elements of low atomic number has been confirmed by the appearance of a very prominent absorption edge of aluminium metal coincident with the aluminium K valence band edge while taking an emission spectra of that metal. This partial absorption of a photon is analogous to Smekal's prediction of the partial absorption of the photon by the electrons of the atom, which could not be detected for free atoms but occurs when the broad Brillouin zones of the insulators are involved.

The probability of this type of scattering seems to be large when the valence band radiation is absorbed by the valence electrons of the particular atom in which the photon originates; that is, somewhat as in the Auger process the K-valence band radiation, while coming out of the atom, becomes degraded in energy by raising the valence electron associated with the particular atom from the filled band to the next vacant allowed band.

In aluminium oxide and silica, etc., the number of parent lines involved is quite large, namely, K_α group of lines of metal ions, K_α of oxygen and K_β band of metal ions. In beryllium oxide and boron trioxide the parent lines involved are K_α of oxygen and metal ion. In diamond, however, the parent line involved is only carbon-K_α. The new type of scattering transition would probably be better detected when the involved beam is more or less monochromatic.

This type of scattering transition at once explains the origin of the long wave-length K valence band satellite of the insulators beryllium oxide, boron trioxide and diamond, and their absence in the same elements in the form of conductors which do not possess any discrete allowed and forbidden zones. The energy difference between the parent exciting radiation and the modified wave-length, that is, the difference between the K valence band peak and its long wave-length satellite, is about 7 eV. in the case of diamond, 13·4 eV. for aluminium oxide and 14·3 eV. for silica. In the case of diamond, this energy difference is determined from the ultra-violet absorption peak. The values for aluminium oxide and silica agree well with the values of the gap between the peak of the valence band and the centre of the first vacant band determined from their soft X-ray emission and absorption spectra. In the case of diamond the agreement is confirmed by: (1) the appearance of the long wave-length K_α satellite at an energy gap of 7 eV. obtained both by Siegbahn and Skinner; (2) the appearance of the ultra-violet absorption band at 7 eV.; (3) Kimball's theoretically calculated result for the distance between the filled band and the first vacant band, which also comes out to be 7 eV. In the case of beryllium oxide and boron trioxide, the energy gap between the centre of gravity of the filled band and the vacant band has not been experimentally determined; but the magnitude of their insulation properties suggests that the gap will be of the same order as that of aluminium oxide and silica, for which the experimental values are about 15 eV. The long wave-length satellites of beryllium oxide and boron trioxide also appear at a gap of about 15 eV.

Experiments on the direct scattering of a monochromatic beam in the soft X-ray region by special methods seem to give a faint indication of this new scattering. It is hoped to confirm this by further experiments and to publish the results shortly.

My thanks are due to Prof. S. N. Bose for his inspiration and encouragement.

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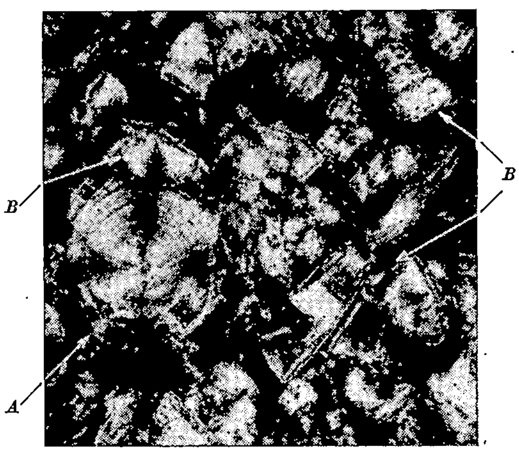
Spherulitic Sectors

DURING the study of soap–oil systems, a unique crystal structure has been observed having the characteristics of an incompletely formed spherulite I have not found in the literature a description of this phenomenon, which for convenience is termed a 'spherulitic sector'.

The system in which the phenomenon was observed contained some 19 per cent of sodium soap dispersed in an acid-refined petroleum oil. The polarizing microscope revealed clusters of small elongated crystals; but after slow, static cooling from 200° C at a rate of less than 1° C. per min. in an enclosed cell, the field appeared as in the accompanying photograph. Among shapeless masses of crystalline material were seen a number of spherulites (A) up to about 200 μ in diameter together with 'spherulitic sectors' (B). 'Spherulitic sectors', which are coloured in white light, have optical properties similar to spherulites; for example, the characteristic black crosses parallel to the planes of the nicols, which



Spherulitic structures in a soap–oil system (crossed nicols; magnification, ×130) remain parallel on rotation of the specimen, can be clearly seen in the photograph. These interference figures have been observed to subtend various angles up to 180°, but none has been seen with a re-entrant angle. Along their radial boundaries they exhibit narrow regions of a higher-order interference colour, these regions indicating an arrangement of soap molecules different from the radial array in the intermediate zones. Cessation of growth of the spherulite may be a direct result of this arrangement at the edges.

I acknowledge the helpful discussions with Mrs. E. V. Garner and Dr. J. B. Matthews, and wish to thank Messrs. "Shell" Refining and Marketing Co., Ltd., for permission to publish this account.

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A Radiation-absorbing Centre in a Non-statical Homogeneous Universe

While studying various problems connected with the birth and later evolutionary stages of stars in the scheme of general relativity, situations are encountered where an infinite spherical distribution of matter suddenly collapses and forms a spherical distribution of finite radius which starts absorbing radiation. Such a 'dark nebula' absorbing radiation cannot be surrounded by an isolated gravitational field tending to flat space-time at large distances because there is nothing in the empty space beyond to supply the energy which it absorbs. We have found spherically symmetric distributions of the form

$$ds^2 = -e^{\alpha}dr^2 - e^{\beta}r^2(d\theta^2+\sin^2\theta d\varphi^2) + e^{\gamma}dt^2, \quad (1)$$

which represent fields of radiation flowing inwards owards the centre and which are such that, at any ime t as $r \to \infty$, the line-element (1) goes off coninuously to

$$ds^2 = dt^2 - e^{g(t)}[(1-r^2/R^2)^{-1}dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2], \quad (2)$$

o that the source of the energy which the distribution absorbs is the cosmos; and we have the field representing the flow of cosmic radiation. One such line-element is given by

$$ {}^{\alpha} = e^{\mu}\,.\,e^{g(t)}\,.\,(1-r^2/R^2)^{-1}, \quad e^{\beta} = e^{\mu}\,.\,e^{g(t)}, \quad e^{\gamma} = 1; \quad (3)$$
$$\mu = \mu(m,r); \quad m = m(r,t).$$

Equations to determine μ and m are

$$\frac{\partial}{\delta r}\left[\frac{1}{rm'}\frac{\partial\mu}{\partial r}\right] - \frac{1}{r}\frac{\partial}{\partial m}\left[m'\frac{\partial\mu}{\partial m}\right] - \frac{1}{r^2}\frac{\partial\mu}{\partial m} = 0; \quad (4)$$

$$(e^{-\alpha/2}\,.\,\partial m/\partial r) - (\partial m/\partial t) = 0. \quad (5)$$

It will be found that $m' = \partial m/\partial r$ will be expressible as a function of m and r only. The energy tensor is of the form

$$T^{\mu\nu} = (p + \rho)v^{\mu}v^{\nu} - pg^{\mu\nu} + \sigma w^{\mu}w^{\nu}. \quad (6)$$

The first two terms represent the material contents of the smoothed-out universe with

$$v^1 = v^2 = v^3 = 0; \quad v^4 = 1; \quad (v^{\mu})_{\nu}v^{\nu} = 0. \quad (7)$$

The last term gives the inflow of radiation[1,2],

$$w^1 < 0; \; w^2 = w^3 = 0; \; w_{\mu}w^{\mu} = 0; \; (w^{\mu})_{\nu}w^{\nu} = 0; \quad (8)$$

and σ is the energy density of the radiation.

Conditions (7) are satisfied by choosing[3] $\gamma = 0$. The equation of continuity takes the form

$$(\sigma w^{\nu})_{\nu}\,w_1 - \partial p/\partial r = 0. \quad (9)$$

There is one field equation:

$$T_1^{\,1} - T_2^{\,2} = -e^{-\alpha/2}\,T_1^{\,4}, \quad (10)$$

which is satisfied in virtue of (4) and (5). m is conserved along a world-line of flow of radiation, and at large distances from the centre

$$e^{\mu} \sim 1 + \frac{\varphi(m)}{r}, \; \varphi(m) \text{ being arbitrary.} \quad (11)$$

Expressions for p, ρ, σ can be worked out.

Complete solutions with cosmogonical applications will be published elsewhere.

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Sieves of Eratosthenes

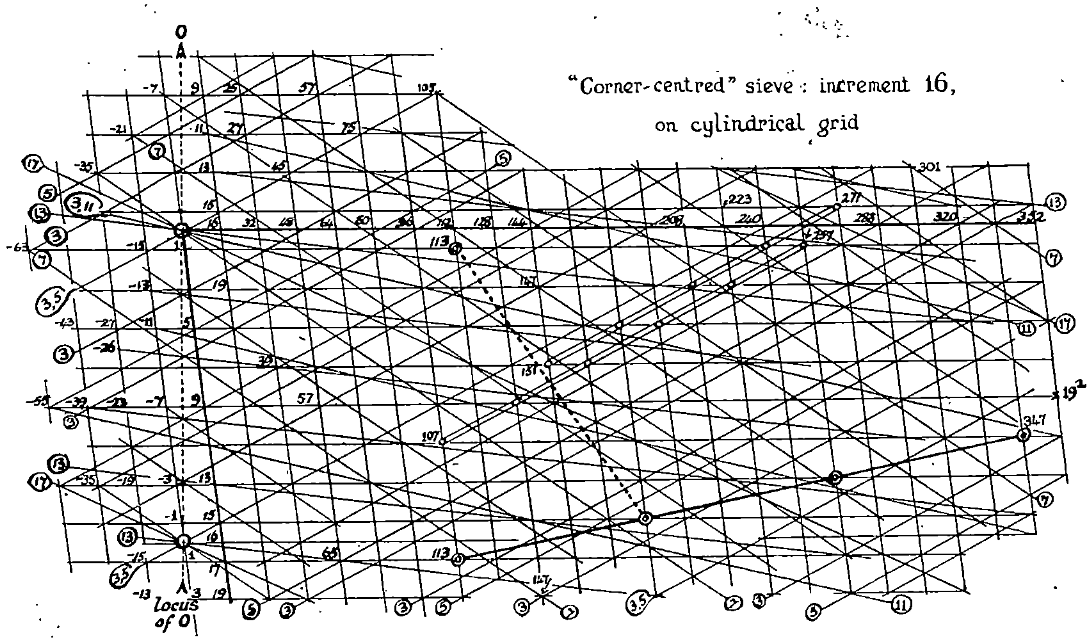
The sieve of Eratosthenes has been used mainly for the determination of prime numbers—a function now presumably archaic. Sieves have other uses, including the finding of primes in arithmetical progression.

Series of primes, such as those listed at the end of this communication, can be found on any sieve providing certain conventions are observed. On the sieves of Fisher[1] or Dantzig[2] the series are not obvious. Series are most easily found when the increment n (100 in Fisher's sieve) is equal to, or approximates to, the common difference d of the progression.

A series is recognized by its forming a straight line of equally spaced row-column intersections. If $n = d$ or $d \pm 2$, the line can be most easily picked out: being horizontal or at 45° respectively (on a rectangular sieve).

I am not very familiar with the literature of sieves or with the theory of primes, but I think that preoccupation with sieves having $n = 100$ or higher powers of 10 may have led to the existence of series being overlooked. Series of three and four terms are numerous, as might be expected; but the number of series of five and six terms (pentads and hexads) among integers up to about 2,000 (the limit of my search) seems relatively large. In all series so far found, d is a multiple of 6, and it is believed that series of more than six primes in arithmetical progression cannot exist.

It has been found possible to construct several types of sieve, all of which are special cases of distinction within and among the continuum of numbers. The classical 'limited' sieve which theoretically extends to infinity in only one direction (say, to the right, as in Fisher's) can be extended in all directions; and a straight line which passes through and eliminates multiples of a given prime from one part of the sieve has, when produced, the same properties everywhere. The region to the left of the lowest-numbered



column—more accurately, to the left of the locus of zero—may be regarded as negative. Each sieve has an infinite number of zeros ; but if only one or both the 'corner' zeros nearest to 1 and n at the top and bottom of the first column are taken into account, then it is possible to adopt a virtually systematic construction for the lines of prime multiples by taking advantage of the fact that 0 has all numbers for a factor, and by drawing lines from 0 through convenient multiples of each prime in succession. By counting the columns traversed by such lines of prime multiples on a 'centred' or Fisher sieve, it is easy to ascertain how many parallels are needed to eliminate all multiples of each prime. The simplest lines of multiples of the primes of n are horizontal.

Fisher's or Dantzig's sieve may be called rectangular, because the rows and columns are at 90°. If the columns are suitably set (at $\tan^{-1} 1/n$ to the rows) the sieve becomes cylindrical, in that the sieve can be wrapped around a cylinder so that the columns, and the lines of prime multiples, form spirals. In a cylindrical sieve, however, the loci are at 90° to the rows, whereas in a 'rectangular' sieve the loci are at $\tan^{-1} 1/n$ to the rows. These hints may sufficiently indicate the interrelationships between sieves, and also the importance of the increment n for the sieve—or, as I prefer to say, for the grid upon which the sieve is constructed.

The accompanying illustration is a composite one giving a fragment of an extended 'corner-centred' cylindrical sieve with $n = 16$, and showing a pentad and a hexad ($d = 30$). There is also a tetrad ($d = 78$), which, as the thick dotted line indicates, would not be fully recognizable as a straight line (that is, as a series of more than three primes) on a 'limited' sieve : this exemplifies the value of extension of the grid. A few numerical values are inserted for guidance.

Series of more than four terms so far found include those of which the lowest terms are given below :

d	30	60	90	96	120
Pentads	37, 151, 277	43	83	5	29, 107, 379, 743, 757
Hexads	107, 359	11, 53	—	—	−167, 239, 281, 701

The same series exist with opposite signs, the distributions being 'mirror-imaged' ; but only one pai has been found having both negative and positive primes.

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Passage of Phosphorus-32 from Dried Yeas into Amphibian Gastrula Ectoderm

Brachet[1] has suggested that an important par is played by ribonucleoproteins or their breakdow products in the evocation of neural tissue in th Amphibian gastrula both by the natural organise and by dead or cytolysing tissues. An experimen has therefore been made in which nucleoprotei incorporating phosphorus-32 was placed in contac with gastrula ectoderm, and a determination mad to see whether the radioactive isotope passed acros into the ectodermal cells. In the preliminary experiment, baker's yeast was grown in a medium containing phosphorus-32 ; the yeast was removed b filtration, washed with water, dried at 140° C. washed again with water, and implanted into th blastocœls of *Triturus alpestris* gastrulæ either as dry powder or after incorporation into a jelly o coagulated egg albumen. After two days, or longer the ectoderm overlying the implant was dissected off carefully washed free of adhering particles, and place in a Geiger counter ; the implant was treate similarly. The number of ionizations produced b single ectoderms was in some, though not all, case clearly above that of the background ; when severa fragments of ectoderm were combined, the result were always positive, as shown in the accompanyin table.

Expt. No.	Material tested	Days after implantation		Ionizations
		Fixed	Counted	
*M*67*A*	5 ectoderms	4	4	503/5 min.
*M*67*B*	5 implants	4	4	3004/5 min.
	Blank			109, 131, 115, 124, 148, 138/5 min.
*M*67*C*	5 ectoderms	4	9	55, 53, 51, 48/min.
*M*67*D*	3 implants	4	9	117, 91, 117, 101, 103/min.
*M*68*C*	7 ectoderms	2	7	29, 30, 39, 37, 41/min.
*M*68*D*	5 implants	2	7	74, 82/min.
	Blank			20, 16, 18, 14/min.

This makes it clear that the phosphorus-32 is taken p by the gastrula ectoderm. It is, of course, not at ll certain that all the phosphorus-32 in the dried east is incorporated into nucleoprotein; and even purified nucleoprotein implants had been made, it ould be possible that these would be degraded and hat the phosphorus-32 is in the form of phosphate on at the time it actually makes the passage into he ectodermal cells. It would seem impossible, by he use of labelled phosphorus alone, to determine hether nucleoprotein as such can pass into the ctoderm. The experiments have therefore been discontinued; they would have been crucial only if it ad been found that phosphorus-32 was not taken p from dried yeast.

I wish to thank Mr. F. H. Krenz, of the Department of Natural Philosophy, University of Edinurgh, for carrying out the counter determinations.

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Effect of Bee Venom on Colchicine-induced Tumours

I HAVE shown that colchicine can act both as an oncogenic[1] and oncolytic[2] agent when administered o plants. Analogous effects were reported in animals y Harde[3] and by me[4] as regards the oncogenic nfluence of the drug, while Dustin[5] and his school ave demonstrated encouraging carcinolytic effects. The nuclear anomalies[6], the stathmokinetic[7], polyploidizing[6,8] and mutagenic[4,9] as well as hormonal[4,10] esponses induced by the alkaloid are equally well nown. The narrow margin between its healing and oxic effects[11], however, including the risk of its oncogenic action, continues to be a serious obstacle o the application of the drug in human cancer herapy.

The reported sterilization of the pollen collected y bees on their arrival at the bee hive[12], including he blocking of the emission of the pollen tube, as confirmed by Baldensperger[13], suggested to me that the ubstance or substances presumably responsible for this inactivation might be a growth-inhibiting agent ith similar antagonistic action on colchicine-induced umours to those already tried[4,14]. Pending the dentification of the secretion producing pollen sterilization, I have used for preliminary trials bee enom, several constituents of which are present in their other secretions and body fluids.

Commercial bee venom ('Apicine', Veleda, St. Louis, France) was used, each 1-c.c. ampoule of hich contained *c.* 0·030 mgm. of venom dissolved n a physiological solution of sodium chloride. The colchicine ('Colchineos', Houdé, Paris) was supplied in 3-c.c. ampoules containing 3 mgm. of the substance dissolved as above.

Seeds of tomato (var. Ailsa Craig) and of wheat (var. Vilmorin 27) were sprouted in Petri dishes on filter paper wetted with dilutions of the above preparations as follows: group 1 received colchicine (1 : 4,000) alone; group 2, bee venom (1 : 7,500) alone; group 3, a mixture of the two substances in the same concentrations and the same proportion; and group 4, serving as controls, tap water containing the same amount of sodium chloride (2 : 1,000) as the above dilutions. Four experiments each lasting about eighteen days were carried out, in the course of which about a thousand seedlings were treated. The total amount of colchicine administered to each of the respective groups during each of the four experiments was 1·6 mgm., and that of the bee venom 0·6 mgm.

Table 1

Plants	Rate of germination (%)				Average height of shoots (mm.)				Average length of roots (mm.)			
	1	2	3	4	1	2	3	4	1	2	3	4
Tomato	85	85	95	90	14	12	18	37	4	4	7	32
Wheat*	87	85	85	96	52	170	71	215	8	44	16	111

Table 2

Plants	No. of tumours per 100 plants		Growth coefficient				Reduction of growth coeff. by venom (%)	Reduction of No. of colch. tumours by venom (%)
	1	3	1	2	3	4		
Tomato			17	17	21	35	52	
Roots	82	26						69
Total	82	26						69
Wheat*			32	79	40	123	36	
Roots	283	151						47
Shoots	50	11						78
Total	333	162						av. 62

1, colchicine treatment; 2, bee venom; 3, bee venom plus colchicine; 4, controls.
* Average of three experiments.

Tables 1 and 2 show some of the results recorded at the end of the experiments. At the beginning, the venom administered alone delayed markedly the germination of tomato; venom and colchicine speeded up germination considerably as compared with colchicine administered alone and even the water controls. A similar paradoxical stimulation of the growth of the shoots and roots was observed under the influence of the combined treatment. Later on, as a consequence of the toxic effects of the drug on the roots, this stimulation decreased gradually.

The reactions of the wheat to the venom were different; for, although when administered alone it inhibited growth processes much less than in tomato, its compensating effects on the depression of growth-rate induced by colchicine were much less marked.

Table 2 shows that the antiblastic influence of the venom was considerable on the tomato roots, which, as is known, are the only organs of these plants which react to the oncogenic action of colchicine administered via the roots.

In wheat, the reduction of tumour incidence was even more marked than would appear from the final results recorded in Table 2, for the appearance of the tumours was also considerably delayed by the venom. In consequence of this delay, the number of root tumours was, in the course of the first half-period of the experiments, up to 60 and that of the shoots up to 650 per cent. below that of the plants treated with colchicine alone. Table 2 also shows that the inhibition of the various growth-processes of the plants, as expressed by their growth coefficient, was less marked than the antiblastic effects of the venom. This indicates a differential sensitivity of the normal and pathological tissues to the drug, as postulated for all agents presumed to be carcinolytic.

Preliminary trials (unpublished) in search of the active principle of the venom have resulted only in the finding that among its alleged constituents tryptophane and choline were practically inactive in reducing colchicine-induced tumours, while palmitic acid had marked therapeutic effects on the induced phytocarcinomata of the tomato. Experiments are being carried out to test the effects of bee venom on these last as well as on their causative agent, *Phytomonas tumefaciens*.

While concluding the present experiments, my attention was directed to a note[15] reporting the reduction of tumour incidence in mice, obtained by Robinson by feeding the animals with pollen stored by the bees in the hive. Fresh pollen had apparently no such effects.

Further research is necessary to identify the various factors in each of these converging actions, and to determine whether the active principle of the substance, or substances, responsible for the inactivation of the pollen, the reduction of colchicine-induced tumours and the carcinolytic effects in mice is identical in each case.

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March 31.

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Methionine Content of Cereals and Legumes

THE methionine content of cereals and legumes widely used in India has been measured. Determinations were made with a Lumetron photo-electric colorimeter using the sodium nitroprusside method of McCarthy and Sullivan[1] as modified by Csonka and Denton[2], and further modified by us[3]. The values shown in the accompanying table give the mean of at least two determinations. It is seen that the vetch pea is very poor in methionine content The relationship between this very low methionin content of the vetch pea and lathyrism has been discussed elsewhere. There is evidence to suppor our view that lathyrism is due to absolute methionin deficiency, aided by some toxic substance whicl further brings about a disturbance in methionin metabolism. It is also apparent that the low nutritiv value of lentil protein is due not to cystine deficienc but to methionine deficiency. The better quality o rice protein is due, at least in part, to the mucl higher methionine content of the former. Furthe investigation is in progress.

Name	Methionine contents (% in sample)
Rice (*Oryza sativa*)	0·21
Wheat (*Triticum vulgare*)	0·08
Maize (*Zea mays*)	0·08
Green gram (*Phaseolus radiatus* Linn.)	0·26
Bengal gram (*Cicer arietinum*)	0·24
Lentil (*Lens esculenta*)	0·07
Vetch pea (*Lathyrus sativus*)	0·06
Red gram (*Cajanus indicus*)	0·15

This work was carried out under the auspices o the Bihar Board of Medical Research.

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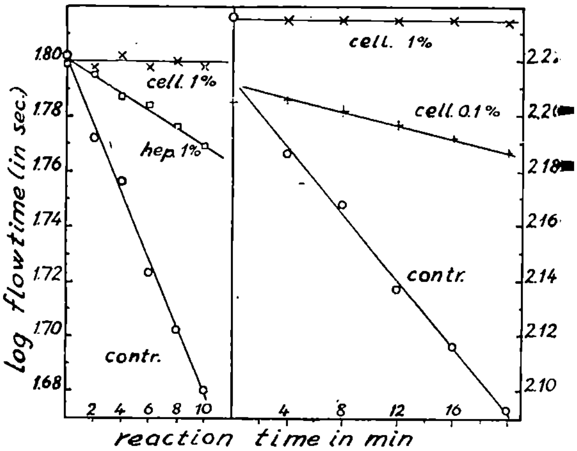
Polysaccharide Polysulphuric Acids as Antihyaluronidases

DURING an investigation of the antiproteolyti properties of polysaccharide polysulphuric acid including heparin, the action of these substances wa tested on hyaluronidase, as representing a depoly merizing enzyme differing from the proteolyti enzymes. The viscosity determinations were carrie out as described by Lundquist[1]. They were recorde with the logarithm of the time of flow (in sec.) as th ordinate. The heparin was a commercial produ (Løvens Kemiske Fabrik, Copenhagen) and the poly sulphuric acids were prepared as previously d scribed[2].

The test solutions had the following composition potassium or sodium hyaluronate in buffer, 3 ml. hyaluronidase solution, 0·5 ml.; inhibitor solutio 0·1 ml. The accompanying graph gives typic results.

Chondroitin sulphuric acid and heparin have bee found to inhibit hyaluronidase[3,4]. According to ou results, the inhibitory action of heparin is low



Inhibitory action of heparin (1 per cent solution) and cellulose-trisulphuric acid (1 and 0·1 per cent solutions as sodium salts) on the depolymerization of two different samples of hyaluronic acid by hyaluronidase from bull sperm and bull testis respectively ompared with that of the synthetic substances. ellulose-trisulphuric acid and chitin disulphuric acid ow a particularly high inhibition. In view of the hemical structure of hyaluronic acid, the inhibitory ction of the substances considered is interesting. s suggested by McClean[3], they appear to compete ith hyaluronic acid for the enzyme, thus blocking s action on hyaluronic acid. The reaction is another xample of the competitive inhibition in biological ystems such as is observed in the sulphonamide--aminobenzoic acid antagonism.

Thanks are due to Dr. F. Lundquist, Copenhagen, nd to Messrs. Leo, Ltd., Helsingborg, Sweden, for amples of hyaluronic acid and hyaluronidase.

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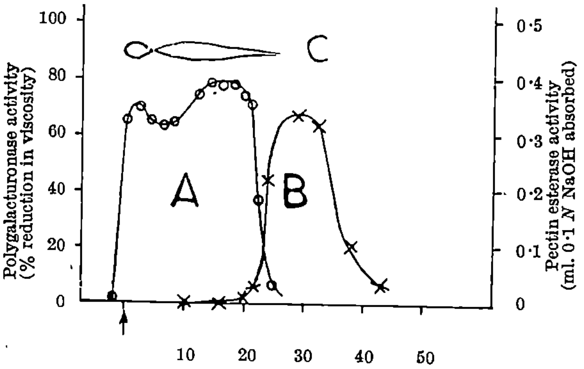
stimation and Separation of the Pectin-Esterase and Polygalacturonase of Micro-fungi

VARIOUS methods for the estimation of pectin-sterase and polygalacturonase have been used[1,2]; ut for rapid examination of cultures of micro-fungi, modification of the 'cup-plate' diffusion method is seful. The polygalacturonase assay is carried out n a medium containing 1·5 per cent agar and 1 per nt sodium pectate at pH 5·0; and after incubation 37° C. for 18 hr., the plates are sprayed with acid, hen the enzyme activity is revealed as clear circular nes on an opalescent background. For the pectin-terase assay, buffer-free agar containing 1 per cent rified pectin and methyl red adjusted to pH 6·0 used, and the activity is indicated as red zones on yellow background, due to the lowering of the pH demethylation of the pectin. With each enzyme ere is a linear relationship between the diameter the zone and the logarithm of the enzyme con-ntration. Other enzymes (amylase, cellulase, lanase, arabanase) may be determined similarly[3], d the activities calculated by the usual method[4,5].

Pectin-esterase and polygalacturonase have been parated by chromatography on sheets of Whatman). 1 and No. 3 papers, using various concentrations buffered salt solutions as developing agents. After velopment, the chromatograms are laid on slabs the gel media described above to indicate the esence of pectin-esterase and polygalacturonase. nder suitable conditions the pectin-esterase travels ore rapidly, and may be separated completely from e slower-moving polygalacturonase.

The area occupied by the enzyme on the chromato-am, and also the zone produced by diffusion into agar substrate gel from the paper strip, is linearly ated to the amount of enzyme applied to the paper. e activity may also be determined by dissecting plicate strips and placing the pieces directly into bes of the respective substrates, in which poly-lacturonase is estimated by a viscometric method[4], d the pectin-esterase activity by titration[7]. This thod is less sensitive than the agar-gel technique, owing to the possible overlap of zones when dissecting the paper (see graph, where the polygalacturonase activity shows two peaks), whereas on an agar-gel a duplicate strip gave clear evidence of two separate zones of activity.



Paper chromatogram of a pectic enzyme preparation from a micro-fungus: (*A*) O—O, zone of polygalacturonase activity; (*B*) ×—×—, zone of pectin-esterase activity; (*C*) tracing of polygalacturonase activity on pectic-acid – agar gel

With some preparations the amylase, pectin-esterase and the polygalacturonase may be resolved into two components. The pectin-esterases from different fungi differ in the total amount of de-esterification of pectin they can accomplish, and in their reaction velocities, which may be correlated with the fact that some preparations appear to have two components, and others only one.

With ammonium sulphate a gradient exists (determined by estimation in the dissected paper strip, or application of a strip to an agar-gel followed by treatment with barium chloride to indicate the concentration of sulphate ion), which *decreases* from the top of the paper down to the solvent front. Other factors, including pH and absorption on the cellulose, also operate.

The technique has been found useful for comparative studies on amylases and related enzymes. Recently[6], partial chromatographic separation of proteins and some enzymes has been reported, using a colorimetric technique for indicating all protein components. The two methods in combination should be useful for indicating inactive components, and overlapping enzyme activities.

Thanks are due to A. Phipps and G. L. Solomons for experimental assistance, and to the directors of this Company for permission to publish these results.

Note added in proof. With acetone–water mixtures as solvents, polygalacturonase and some amylases (β, bacterial, salivary, malt) may be resolved into two, and fungal amylase into four, components; duplicate chromatograms by the technique of Quastel and Franklin do not indicate this resolution.

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May 2.

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An Antibiotic, Thermophillin, from *Lenzites thermophila*

CULTURE fluids of *Lenzites thermophila* Falck 75, a Basidiomycete, were shown by Wilkins[1] to inhibit the growth of *Staph. aureus*. An antibiotic with quinonoid properties has now been isolated from the culture fluid of this fungus, which was grown at 24° C. on a 5 per cent extract of malt medium. Culture medium was kindly provided by Mrs. D. E. Gill-Carey.

The culture fluid was adjusted to *p*H 5, saturated with sodium chloride, and the active principle was then extracted with one volume of chloroform. The chloroform solution was concentrated *in vacuo*, washed with sodium carbonate solution, which removed inactive material, and chromatographed on 60/100-mesh 'Florisil' (magnesium silicate). The main active substance passed through the column on washing with chloroform. After further washing with chloroform/ethanol, acetone and aqueous acetone, which eluted inactive material, a small quantity of a second active substance was removed with phosphate buffer of *p*H 8. The latter active substance was phenolic. The fractions containing the main active substance yielded impure crystalline material on evaporation. This was rechromatographed and crystallized from ethyl acetate. The antibiotic, which has been named 'thermophillin', formed golden plates. It volatilized when heated to 245° C. and decomposed at 260° C. when heated in a sealed tube. (Found (Weiler and Strauss), C, 56·7, 57·2; H, 4·77, 4·62; OCH_3, 35·0, 35·2; $C_{14}H_6O_5(OCH_3)_4$ requires C, 57·2; H, 4·5; OCH_3, 32·8.)

Thermophillin is almost insoluble in most organic solvents, and is only very sparingly soluble in ethanol, ether and water. It is slightly soluble in chloroform.

It is rapidly destroyed in aqueous solution at room temperature at *p*H 9; but is stable at *p*H 2 and *p*H 7 on heating at 100° C. for 15 min. and at *p*H 7 on boiling for one hour.

It shows a weak activity against *Staph. aureus* when tested by the cylinder plate method. At a concentration of 1 in 10,000 it gave a zone of inhibition 15 mm. in diameter.

Thermophillin gives a yellow solution in water, which changes to red on the addition of sodium hydroxide. It liberates iodine from acid potassium iodide solution and is reduced to a colourless compound with sodium hydrosulphite. Concentrated sulphuric acid gives an immediate bright red coloration which becomes brown on heating and yellow on the addition of ethanol.

On reduction with zinc dust and warm hydrochloric acid, a colourless phenolic substance was produced which crystallized from chloroform in long colourless needles (m.p. 172° C.). These became pink on exposure to air and in a vacuum desiccator, and then rapidly darkened. This compound showed slight activity against *Staph. aureus* by the cylinder plate test. (Found, C, 56·3; H, 5·74; Act. H, 1·62; OCH_3, 34·7; $C_{18}H_{22}O_9$ requires C, 56·5; H, 5·75; and $C_{18}H_{20}O_9$ requires C, 57·0; H, 5·27 per cent.)

On acetylation with acetic anhydride and anhydrous sodium acetate, the phenolic substance yielded an acetyl derivative which separated from glacial acetic acid in the form of small needle-shaped crystals (m.p. 184° C.). This acetylated product was also obtained, though in smaller yield, by acetylation of thermophillin with acetic anhydride and sulphur acid.

Acknowledgment is made to Miss Jean Moss f technical assistance in the course of this work.

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July 17.

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Plasticity of Wool

IT has already been shown that the slow extensio of wool fibres under constant *stress* in water a ordinary temperatures has the characteristics of first-order reaction; when log $(E - E_t)$ is plotte against t, where E_t is the extension at time t, a linea relationship is obtained[1]. As the slowly extende fibres return to their original length on being release in water, even from extensions so great as 70 pe cent, molecular slip is excluded, and it seemed prob able that a similar, but more precise, relationshi would be obtained by extending fibres under constan *load*. This deduction has been confirmed with Lincol wool fibres in water at 22·2° C. under a load o 7×10^5 gm. per sq. cm. of the original cross-section area.

Although the root ends of non-medullated fibre taken from a single lock of wool were used, th slopes (k) of the lines obtained by plotting lo $(E - E_t)$ against t were found to vary from $- 50{\cdot}2 \times 10^{-5}$ to $- 3{\cdot}83 \times 10^{-5}$, the extensio being expressed as percentages and the time i minutes. The fibres were divided into three grou according to their rates of extension, and when few milligrams of each type had been accumulate their sulphur contents were determined. The resul and the average values of k for the three groups a given in the accompanying table.

No. of fibres	Sulphur content (%)	k ($\times 10^{-5}$)	$C = k \times S$ ($\times 10^{-5}$)
30	3·97	− 6·0	−23·8
15	2·27	− 8·7	−19·7
18	0·98	−24·7	−24·2

If due account is taken of the difficulty of deter ining the sulphur content of 1·2–2·4 mgm. wool, the product C of slope and sulphur conte may be regarded as constant. The inverse relatio ship between the rate of extension and the sulph content of the fibres is, of course, to be expected the chief resistance to the unfolding of molecules the crystalline phase is provided by cystine cros linkages.

Similar variations in rate of extension under co stant load have been observed in the case of huma hair, but the value of C is different from that f Lincoln wool. It seems clear, therefore, that th plasticity of animal fibres is not determined sole by their cystine content. The influence of oth factors, including the amorphous/crystalline rati should be capable of elucidation by classifying diffe ent types of fibre in accordance with the values C.

Several important possibilities are revealed b these observations. Determinations of k with fibr taken from selected sites on the skin of the anim should provide the biologist with a simple micr ethod of studying the factors which influence the onstitution and structure of animal fibres, and should eveal the cause of the remarkable variations in the ulphur content of fibres within a single lock. In ddition, determinations of C for different types of ool may, for the first time, provide the craftsman ith a measure of characteristics which he still lentifies by combining a skilled tactile judgment ith the results of long experience in the processing f wool.

We are indebted to the International Wool ecretariat for grants in aid of this investigation, nd to Dr. G. Weiler and Dr. F. B. Strauss for the ulphur-content determinations.

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Speakman, *Nature*, 159, 338 (1947).

Behaviour of *Plasmodium berghei* in some Rodents

Plasmodium berghei Vincke and Lips 1948 is the rst plasmodium found infective for rats and mice[1]. incke and Lips isolated this parasite from a wild ree-rat *Thamnonys* and found that it produced a atal infection in mice and rats.

Apart from mice and rats, we have found *P. erghei* infective for the golden hamster *Mesocricetus uratus* and for the field vole *Microtus guntheri*. In he hamster *P. berghei* produces a fatal infection in lmost all cases within a period of eight to twenty-ine days after inoculation. The infection is pro-ressive, and the final parasitæmia may involve up 50 per cent of the circulating red cells.

P. berghei is non-pathogenic for the local non-plenectomized field vole *Microtus guntheri*, in which produces a transient patent infection involving 3–10 per cent and exceptionally up to 30 per cent f the red cells. The patent period lasts about a rtnight, and the infection then becomes latent except r the occasional finding of rare parasites in blood nears.

During the latent phase, parasites can be demon-rated either by inoculation of whole blood or acerated spleen or liver into susceptible animals, or y splenectomy which is generally followed by a high arasitæmia and death.

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Upper Limit of Frequency for Human Hearing

THE frequency above which air-borne sound ecomes inaudible is generally considered to be bout 20 kc./s. All sensitivity determinations agree hat the threshold rises very steeply above 12 kc./s. ; nd above 12 kc./s. there are indications that fre-uency discrimination begins to fail, that is, that the least discriminable increment of frequency measured as a fraction of an octave begins to rise sharply. It seems to have been tacitly assumed that the human cochlea is incapable of response to frequencies above 20 kc./s., and that the upper limit for air-borne and bone-conducted sound is the same.

I have compared these limits on myself and two other subjects, using an oscillator of frequency variable up to 120 kc./s. and a transducer consisting of a pack of Rochelle salt plates resonant at 100 kc./s. In all cases the upper limit for air-borne sound, with the transducer held close to the external meatus of the subject, was below 16·5 kc./s. When, however, the crystal was pressed firmly on the mastoid or on the temporal region, a sound was heard for all frequencies up to at least 100 kc./s. In the former case the sound was perceived in the ipsilateral, in the latter in the contralateral ear. The failure at and above 100 kc./s. was at least partly instrumental, due to the failure of the oscillator to maintain an adequate voltage across the falling impedance of the crystal.

The sensation of pitch associated with the sound was approximately that of the highest tone audible by air conduction. As the frequency was varied continuously from 12 to 100 kc./s., the pitch rose with it to 15 kc./s. and stayed there as the frequency was further increased. No extraneous sensations, for example, of warmth, pain or discomfort, were induced and the sound heard was subjectively a perfectly normal tone.

It must be concluded: (1) that the sensory elements at the basal end of the cochlea are competent to respond to sounds up to 100 kc./s. in frequency; (2) that the failure of the normal ear to respond to air-borne sounds above 20 kc./s. is due wholly to the failure of the middle ear to transmit such frequencies.

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Anharmonicity of the Lattice Oscillations in the Alkali Halide Crystals

IN my note under the above title, published in *Nature* of July 15, there are two errors to which I wish to direct attention.

(1) The oscillation discussed there, namely, of the two interpenetrating lattices of Na^+ and Cl^- ions respectively, relatively to each other, is unique among the normal modes of oscillation of the crystal in that it polarizes the medium[1]. The effect of this is to reduce the coefficient of r^2 in equation (2) from a to $a-\frac{4\pi}{3}-\frac{e^2}{8d^3}$. Equating this coefficient to $\pi^2\mu\nu_0^2$, we get the frequency ν_0, the value of which remains the same as given in the note.

(2) The coefficient f appearing in equations (4) and (5) refers to a *pair* of ions, and will be double that defined by (3). This will make the magnitude of the anharmonicity and the rate of fall of C_v with temperature twice those given in the note.

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Aug. 18.

[1] See Kellermann, *Phil. Trans. Roy. Soc.*, A, 238, 513 (1940).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 2

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. K. A. Zandstra: "High Frequency Heating in Industry".

Tuesday, October 3

CHADWICK PUBLIC LECTURE (at the Art Gallery, Plymouth), at 4.30 p.m.—Mr. S. E. Finer: "Chadwick and the General Board of Health, 1848–1854".*

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. R. G. Griffiths: "The London Station Cable and Wireless Telegraph Section, L.T.R.—an Engineering Survey".

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL OF THE AGRICULTURE GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. E. A. Parkin: "Biological Tests of Insecticides for Stored Products Insects".*

Wednesday, October 4

PHYSICAL SOCIETY, COLOUR GROUP (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Mr. R. G. Horner and Mr. E. T. Purslow: "The Dependence of Anomaloscope Matching on Field Size"; Dr. E. N. Willmer: "Some Aspects of Colour Adaptation in the Central Fovea".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, October 5

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir Archibald J. Gill: Inaugural Address as President.

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-WESTERN SECTION (at the College of Technology, Manchester), at 6.45 p.m.—Dr. P. F. R. Venables: "Education in Industry".

Friday, October 6

TEXTILE INSTITUTE (at St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. G. H. Jolley: "The Economics of Productivity".

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. B. Ungerson: "Statistical Problems of Personnel Management".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at Cheetham Town Hall, Manchester), at 6.30 p.m.—Dr. A. S. C. Lawrence: "Topics in Colloid Chemistry". (Further Lecture on October 13.)

BRITISH PAPER AND BOARD MAKERS' ASSOCIATION, TECHNICAL SECTION, NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. N. O. Clark and Mr. R. J. Booth: "Some Aspects of China Clay in Paper".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the Glasgow Section, at the Royal Technical College, Glasgow), at 7.15 p.m.—Dr. E. H. Callow: "Frozen Meat".

Saturday, October 7

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Prof. D. M. Newitt, F.R.S.: "Operating Conditions in High Pressure Plant".

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Westminster, London, S.W.1), at 6 p.m.—Report on First European Astronautical Congress.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EXPERIMENTAL OFFICERS (temporary) in the Mechanical Engineering Research Organisation, Department of Scientific and Industrial Research, (*a*) for the application of electronic techniques to the measurement of transient forces and small movements (Ref. D.48/50A), and (*b*) for fundamental research on the machinability of materials and on the physical processes involved in the cutting of metals (Ref. C.504/50A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 7).

LECTURER IN CHEMISTRY—The Principal, Acton Technical College, High Street, Acton, London, W.3 (October 7).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (October 7).

PSYCHOLOGIST FOR BURDEN MENTAL RESEARCH DEPARTMENT—The Secretary, 25 Albert Road, Clevedon, Somerset (October 7).

RESPONSIBLE LECTURER IN PRODUCTION ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (October 7).

SENIOR EXPERIMENTAL OFFICER (unestablished), or SENIO SCIENTIFIC OFFICER (unestablished), in the Mechanical Engineerin Research Organisation, Department of Scientific and Industria Research, to be largely responsible for the design, development and specification of measuring instruments and apparatus for a new laboratory, where basic problems of fluid mechanics and those related to flow conditions in models of pumps, etc., will be studied—The Ministry of Labour and National Service, Technical and Scientifi Register (K), York House, Kingsway, London, W.C.2, quotin C.505/50A (October 7).

LECTURER IN BIOLOGY (preferably with qualifications in physiology)—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (October 9).

ASSISTANT ARCHÆOLOGY OFFICER in the Ordnance Survey Department—The Secretary, Civil Service Commission, Burlington Gardens London, W.1, quoting No. 3298 (October 12).

HEADMASTER OF ROYAL HOSPITAL SCHOOL, Holbrook, Ipswich—The Director of Greenwich Hospital, Admiralty, 14 Buckingham Gate, London, S.W.1 (October 16).

LECTURER IN METALLURGY in the School of Mines and Metallurgy University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square London, W.C.1 (October 20).

PRINCIPAL RESEARCH OFFICER, Dairy Research Section, Melbourn —The Chief Scientific Liaison Officer, Australian Scientific Liaiso Office, Africa House, Kingsway, London, W.C.2, quoting No. 3017 (October 21).

SENIOR LECTURER IN PHYSIOLOGY at the University of Queenslan —The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 23).

CHAIR OF ELECTRICAL ENGINEERING in the University of Cape Tow —The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, October 30)

LECTURER IN CIVIL ENGINEERING at Canterbury University College New Zealand—The Secretary, Association of Universities of th British Commonwealth, 5 Gordon Square, London, W.C.1 (Octobe 30).

CHAIR OF SOCIAL STUDIES in the University of Natal, Durban—Th Secretary, Association of Universities of the British Commonwealth 5 Gordon Square, London, W.C.1 (October 31).

LECTURER (or SENIOR LECTURER) IN GEOGRAPHY at Auckla University College, New Zealand—The Secretary, Association o Universities of the British Commonwealth, 5 Gordon Square, London W.C.1 (October 31).

READER IN PSYCHOLOGY at the University of Adelaide—Th Secretary, Association of Universities of the British Commonwealth 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER and LECTURER IN THE DEPARTMENT OF MATHE MATICS AND APPLIED MATHEMATICS, and a SENIOR LECTURER (Stat stics), University of Natal, Durban—The Secretary, Association o Universities of the British Commonwealth, 5 Gordon Square, London W.C.1 (October 31).

SENIOR LECTURER or LECTURER IN MATHEMATICS (with spec interest in geometry), in the University of Malaya—The Secretary Inter-University Council for Higher Education in the Colonies, Gordon Square, London, W.C.1 (October 31).

LECTURER IN BIOCHEMISTRY—The Registrar, Massey Agricultura College, Palmerston North, New Zealand (November 15).

CHAIR OF PHARMACOLOGY—The Registrar, The University, Live pool (November 18).

ASSISTANT (graduate in chemistry preferred), to undertake analytic biochemistry work in the Research Unit for Juvenile Rheumatism—The Director, Special Unit for Juvenile Rheumatism, Canadian Re Cross Memorial Hospital, Taplow, Maidenhead, Berks.

CHEMIST, preferably with agricultural experience, for researc work on factors affecting digestibility—The Secretary, Rowett Researc Institute, Bucksburn, Aberdeenshire.

DEMONSTRATOR IN AGRICULTURAL CHEMISTRY at the School Agriculture, Sutton Bonington—The Registrar, The Universit Nottingham.

LECTURER IN THE DEPARTMENT OF AERONAUTICS—The Head the Aeronautics Department, City and Guilds College, Exhibitio Road, London, S.W.7.

PHYSICIST (with a degree in physics and aptitude for practica experimental work)—The Director of Research, Lace Researc Association, 71 Upper Parliament Street, Nottingham.

PHYSICISTS (4) for fundamental research on the properties of matt —The Secretary, British Rayon Research Association, Barton Doc Road, Urmston, Manchester.

SCIENTIFIC OFFICERS (with honours, or equivalent, degree), f research on silage making investigations and ley utilization investig tions, and ASSISTANT EXPERIMENTAL OFFICERS (with degree or simil qualification in agriculture) for research on identical twin collecti and rearing, experimental work with pigs, and experimental work o milking technique—The Secretary, National Institute for Research i Dairying, Shinfield, Reading.

SENIOR PHYSICIST—The Medical Director, Hogarth Radiother peutic Centre, Nottingham.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in variou Government Departments, and covering a wide range of scientifi research and development in most of the major fields of fundament and applied science—The Secretary, Civil Service Commissio (Scientific Branch), 7th Floor, Trinidad House, Old Burlington Stree London, W.1, quoting No. 2887.

SURVEYORS to carry out topographical and cadastral surveys i Kenya—The Director of Recruitment (Colonial Service), Coloni Office, Sanctuary Buildings, Great Smith Street, London, S.W. quoting No. 27076/23.